U.S. ARMY ENGINEER DIVISION
HUNTSVILLE, ALABAMA

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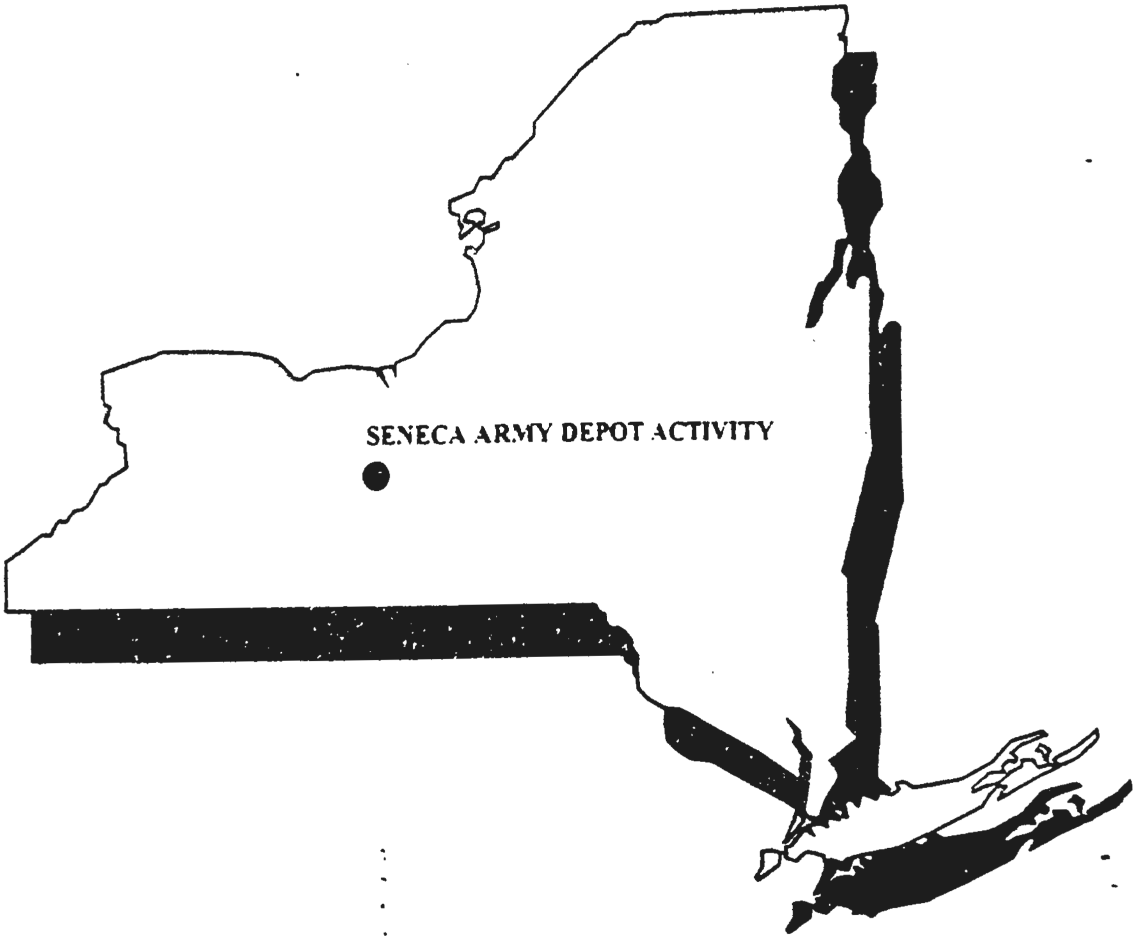

ACTION MEMORANDUM FOR THE MISCELLANEOUS COMPONENTS BURIAL SITE (SEAD-63) SENECA ARMY DEPOT ACTIVITY

CONTRACT NO. DACA87-95-D-0031
DELIVERY ORDER No. 0011

FINAL
OCTOBER 2001

ACTION MEMORANDUM
FOR THE
MISCELLANEOUS COMPONENTS BURIAL SITE (SEAD-63)

REVISED FINAL ACTION MEMORANDUM
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AA	Atomic absorption
ABS	Absorption Fraction
AEC	Atomic Energy Commission
AEHA	Army Environmental Hygiene Agency
AET	Actual Evapotranspiration
ALARA	As Low as Reasonably Achievable
AMC	U.S. Army Material Command
AN	Army-Navy
ANOVA	Analysis of Variance (Test)
AOC	Area of Concern
APCS	Air Pollution Control System
AQCR	Genesee-Finger Lakes Air Quality Control Region
ARAR	Applicable or Relevant and Appropriate Requirements
AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
AW	Drilling Rod Size
AWQC	Ambient Water Quality Criteria
AWQS	Ambient Water Quality Standards
B	Boring
BAF	Bioaccumulation Factor
BALAT	Benthic Aquatic Life Acute Toxicity Criteria
BALCT	Benthic Aquatic Life Chronic Toxicity Criteria
BAP	Benzo(a) Pyrene
BCF	Bioconcentration Factor
BDL	Below Detection Limit
bls	below land surface
BOD	Biological Oxygen Demand
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
BTEX	Benzene, Toluene, Ethylbenzene and Xylene

C	Carcinogenic Risk
C	Classification: For water Class C denotes all surface waters
CA	Concentration of Particulate-Associated Chemicals in Ambient Air
$CaCO_3$	Calcium Carbonate
CEC	Cation exchange capacity
CERCLA	Comprehensive Environmental Response. Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
Cl	Chloride
CLP	Contract Laboratory Program
cm	Centimeters
cm/sec	Centimeters per second
CME	Central Mine Equipment
COC	Chemical of Concern
COD	Chemical Oxygen Demand
COPC	Chemical of Potential Concern
cpm	counts per minute
Cr	Chromium
CRAVE	USEPA Carcinogen Risk Assessment Verification Endeavor
CRT	Cathode ray tube
CSM	Conceptual Site Model
CT	Central Tendency
CV	Coefficient of Variance
D	Absorbed Dose
DA	Absorbed Dose Per Event
DARCOM	Development and Readiness Command
DCE	Dichloroethylene
DCGL	Derived Concentration Guideline Levels
DCT	Dose Conversion Factor
DDD	1.1-Dichloro - 2-(o-chlorophenyl) - 2-(p-chlorophenyl)
DDE	1.1-Dichloro - 2-(p-chlorophenyl) - 2-(o-chlorophenyl)
DDT	1.1.1-Trichloro - 2-(0-chlorophenyl) - 2-(p-chlorophenyl) ethane
DERA	Defense Environmental Restoration Account
DES	Diethyl Stilbestrol
DO	Disolved Oxygen

DOA	Department of the Army
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
dpm	Disintegrations Per Minute
DQO	Data Quality Objective
DRMO	Defense, Revitalization and Marketing Office
DWQS	Drinking Water Quality Standard
E	The Emission Rate
EBS	Environmental Baseline Study
ED	Exposure Duration
EEC	Expected Exposure Point Concentration
EF	Exposure Factors/Frequency
Eh	Oxidation Reduction Potential
EIS	Environmental Impact Statement
EM	Electromagnetic
EMSOFT	Emission Model for Soil Organic Fate and Transport
EPA	Environmental Protection Agency
EPC	Explosive Point Concentration
EPM	Equivalent Porous Media
EPT	Ephemeroptera, Plecoptera and Tricoptera
EQ	Ecological Quotient
ERA	Ecological Risk Assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERQ	Ecological Risk Quotient
ES	Engineering-Science, Inc.
ESE	Environmental Science and Engineering
ESF	Environmental Science and Forestry
ESI	Expanded Site Inspection
ET	Exposure Time Per Event
FDA	Food and Drug Administration
FCM	Food Chain Multipliers
FI	Fraction Ingested
FIDLER	Field Instrument for the Detection of Low Energy Radiations

FMP	Forest Management Plan
FS	Feasibility Study
ft	Feet
ft/day	Feet per day
ft/ft	Feet per foot
ft/sec	Feet per second
ft/yr	Feet per year
FWIA	Fish and Wildlife Impact Analysis
FWMP	Fish and Wildlife Management Plan
g	gram
GA	Classification: The best usage of Class GA waters is as a source of potable water supply. Class GA waters are fresh groundwaters
GAE	Geophysical anomaly excavations
GC	Gas chromatograph
GC/MS	Gas chromatograph/Mass spectrum
gpm	Gallons per minute
GPR	Ground penetrating radar
GRI	Gas Research Institute
GSSI	Geophysical Survey Systems. Inc.
H	Dose Equivalent
H3	Tritium
HEAST	Health Effects Assessment Summary Tables
HHB	Human Health Bioaccumulation Criteria
HI	Hazard Index
HMX	Octahydro-1.3.5.7-Tetranitro-1.3.5.7-Tetrazocine
HQ	Core Barrel Size/Hazard Quotient
HSDB	Hazardous Substances Data Bank
HSWA	Hazardous and Solid Waste Amendments
I	Infiltration
IAG	Interagency Agreement
ICF	ICF Technology. Incorporated
IDW	Investigation Derived Waste
ILCR	Incremental Lifetime Cancer Risk

IR	Ingestion Rate
IRIS	Integrated Risk Information System
IRM	Interim remedial measure
IRP	Installation Restoration Program
K_d	Partitioning Coefficient
K_h	Hydraulic Conductivity
Koc	Organic carbon coefficient
K_p	Permeability Coefficient
LC50	Median Lethal Concentration
LD50	Median Lethal Dose
L/min	Liters per minute
lb	pound
LEL	Lowest Effect Level
LOAEL	Lowest Observed Adverse Effect Level
LOT	Limit of Tolerance
LRA	Local Redevelopment Authority
m	meter
m/s	meter per second
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manual
MCL	Maximum Contaminant Level
MCPA	4-Chloro-2-Methylphenoxy acetic acid
MCPP	4-Chloro-2-Methylphenoxy-2-propionic acid
MCRW	Microwell
MDC	Minimum Detectable Concentration
mg/kg	Milligrams per kilogram
mg/L	Micrograms per liter
mg/l	Milligram per liter
mg/m_3	milligrams/cubic meter
MHz	Megahertz
mi	mile
MIE	Monitoring Instruments for the Environment, Inc.
Miniram	Miniature Real-Time Aerosol Meter
ML	Inorganic Silt

mL	Milliliter
mL/g	milliliter per gram
mmHg	Millimeters Mercury
mmhos/m	Millimhos per meter
mR	Milli Roentgen
MRD	Missouri River Division
mrem	milli roentgen equivalent man
MSL	Mean sea level
MW	Monitor Well
NA	Not analyzed or not available
NAVA	North American Vertical Datum
NBS	National Bureau of Standards
Nc	Noncarcinogenic
NGVD	National Geologic Vertical Datum
NOAA	National Oceanic Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPL	National Priority List
NRC	Nuclear Regulatory Commission
NRMP	National Resources Management Plan
NSF	National Sanitation Foundation
NTU	Nephelometric turbidity units
NW	Drilling Rod Designation
NWI	National Wildlife Institute
NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OB	Open Burning
OD	Open Detonation
ODAST	One Dimensional Analytical Solute Transport
OU	Operational Unit
OV	Specific Ovid Quadrangle
OVM	Organic Vapor Meter

PAH	Polynuclear Aromatic Hydrocarbon
Parsons ES	Parsons Engineering Science, Inc.
Pb	Lead
PCB	Plychlorinated Biphenyls
pCi	pico Curies
PDM	Miniature Real-time Aerosol Monitor Model
PERC	Percolation
PET	Potential Evapo Transpiration
PID	Photoionization detector
ppm	parts per million
ppmv	Part Per Million Per Volume
PM	Particulate Matter
PPE	Personal Protective Equipment
PR	Percent Recovery
PSCR	Preliminary Site Characterization Report
Psi	Pounds per square inch
PT	Monitoring Well
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RAGS	EPA Risk Assessment Guidance for Superfund
RAT	Radiological Assistance Team (onsite Army)
RCRA	Resource Conservation and Recovery Act
RF	Response factor
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
ROPC	Radionuclides of Potential Concern
RPD	Relative Percent Difference
RQD	Rock Quality Designation

SAF	Society of American Foresters
SARA	Superfund Amendments and Reauthorization Act
SB	Soil boring
SCS	Soil Conservation Service
SD	Sediment
SDEF	Standard Default Exposure Factors
SDG	Sample Delivery Group
SEAD	Seneca Army Depot (old name)
sec	Seconds
SEDA	Seneca Army Depot
SF	Slope Factor
SFF	Site Foraging Factor
SI	Site Investigation
SIPT	Seismic Interpretation Program Terminal
SIR	Subsurface Interface
SKC	Supplier of Air Sampling Equipment
SO_4	Sulfate
SOP	Standard Operating Procedures
SOW	Scope of Work
SOW	Statement of Work
SQL	Sample Quantitator Limits
SS	Soil sample
ST	Soil Moisture
STF	Soil Transport and Fate
SUNY-ESF	State University of NY College of Environmental Science and Forestry
SVO	Semivolatile Organic Compounds
SVOCs	Semi-Volatile Organic Compounds
SW	Sediment and surface water sample station
SWMU	Solid Waste Management Unit
T^*	Lag Times/Breakthrough Times for an Organic Compound
T1,2-DCE	trans-1,2-Dichloroethylene
TAGM	New York State Chemical And Administrative Guidance Memorandum
TAL	Target analyte list
TCE	Trichloroethylene
TCL	Target compound list

TCLP	Toxicity Characteristics Leaching Procedure
TDS	Total dissolved solids
TEC	Toxicological Endpoint Concentration
TEDE	Total Effective Dose Equivalent
TEF	Toxicity Equivalency Factor
TEL	Threshold Effects Level
TES	Target Environmental Services, Inc.
TIC	Tentatively Identified Compound
TKN	Total Kjeldah Nitrogen
TLD	Thermoluminescent Detector
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TP	Test Pit
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recovered Petroleum Hydrocarbons
TRV	Toxicity Reference Value
TS	Total Solids
UCL	Upper Confidence Limit
ug/g	Micrograms per gram
ug/kg	Micrograms per kilogram
ug/L	Micrograms per liter
ug/mg	Micrograms per milligram
ug/wp	Micrograms per wipe
uR	micro Roentgen
URF	Unit Risk Factor
USACE	United States Army Corps of Engineers
USAEHA	United States Army Environmental Hygiene Agency
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
UV/VIS	Ultraviolet/Visible

UXB	Unexploded Ordnance Clearance Subcontractor
UXO	Unexploded Ordnance
VC	Vinyl Chloride
VLF-EM	Very Low Frequency Electromagnetic
VOA	Volatile organic analyte
VOC	Volatile Organic Compound
Vs	Volt Second
WB	Wildlife Bioaccumulation
WL	Working Level (see page 3-7 for a definition)
WRS	Wilcoxon Rank Sum Test
WSA	Weapons Storage Area

REFERENCES

Eisenbud, M. and Gesell, T. 1997. Environmental Radioactivity From Natural, Industrial, and Military Sources. 4th Edition. Academic Press, San Diego, CA.

Gilbert, 1987. Statistical Methods for Environmental Pollution Monitoring.

Lasala, A.M., Jr., 1968. Groundwater Resources of the Erie-Niagra Basin, New York. basic Planning Report ENB-3, State of New York Conservation Department with Resources Commission.

Martin and Johnson, 1989. Hazardous Waste Management Engineering. Edward J. Martin, and James H. Johnson, Jr., editors. New York: Van Nostrand Reinhold Company.

Mazola, A.J., 1951. The Groundwater Resources of Seneca County, New York Bulletin GW-26. Water, Power, and Control Commission, Department of Conservation, State of New York, Albany, New York.

Michel, R. L. and Kraemer, F. 1995. Journal of Hydrology. Vol. 164. pp. 1-18

Muller, E.H., and Cadwell, D.H., 1986. Surficial Geologic Map of New York State Finger Lakes Sheet. Survey, Map, and Chart Series No. 40.

Multi-Agency Radiological Site and Survey Investigation Manual, (MARSSIM, NUREG-1575, EPA 402-R-97-016) December 1997.

New York State Department of Environmental Protection (NYSDEC), Division of Hazardous Waste Remediation, Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, January 24, 1994.

NYSDEC, Division of Fish, Wildlife and Marine Resources, Technical Guidance for Screening Contaminated Sediments, January 1999.

NYSDEC. Division of Water Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, Reissue Date June 1998.

New York State Department of Environmental Conservation (NYSDEC), 1989a. Clean-up Criteria for Aquatic Sediments. Department of Environmental Conservation, Albany, New York.

New York State, Division Technical and Administrative Guidance Memorandum (TAGM): Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites: October 1994.

Parsons Engineering Science, Inc., Expanded Site Inspection Report for Seven Low Priority SWMUs, April 1995a.

Parsons Engineering Science, Inc., Expanded Site Inspection Report for Three Moderately High Priority SWMUs, April 1995b.

Parsons Engineering Science, Inc., Generic Installation RI/FS Workplan, June 1995c.

Parsons Engineering Science, Inc., Project Scoping Plan for Performing a CERCLA RI/FS Study June, 1998.

Sims, 1990. "Soil Remediation Techniques at Uncontrolled Hazardous Waste Sites, a Critical Review," by Ronald C. Sims. Journal of the Air and Waste Management Association, (May 1990) 703-732.

SCS, 1972. Soil Survey of Seneca County, New York. U.S. Department of Agricultural, Soil Conservation Service.

Todd, D.K., 1976. Groundwater Hydrology. John Wiley and Sons, New York.

USEPA, 1988a. Technology Screening Guide for Treatment of CERCLA Soils and Sludges. EPA/540/2-88/004. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1988b. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. EPA/540/G-89/004. Washington, D.C. U.S. Environmental Protection Agency.

EPA. 1990. Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils. EPA/540/2-90/002. Washington, D.C.: U.S. Environmental Protection Agency.

United States Army Toxic and Hazardous Materials Agency (USATHAMA), 1989. Seneca Army Depot Landfill/Burning Pit Site Investigation.

1.0 INTRODUCTION

1.1 PURPOSE, SCOPE, AND OBJECTIVES

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared for SEAD-63 at the Seneca Army Depot (SEDA) by Parsons Engineering Science (Parsons ES) in support of the proposed non-time-critical removal action. Parsons ES has been retained by the United States Army Corps of Engineers (USACE) Huntsville Division as part of their remedial response activities under the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA) to perform these activities.

The purpose of this removal action is to mitigate the source of heavy metals and possible radionuclides through the removal of debris and soils, thereby reducing the chance of further degradation of soils and groundwater at SEAD-63. Although site conditions do not currently pose a human health risk based on the results of a mini-risk assessment, the presence of buried objects, such as drums, is of concern, since the nature of the drum contents are unknown. Furthermore, some buried components deposited at SEAD-63 may still be classified or sensitive and would need to be examined by appropriate military personnel for evaluation and declassification. The uncertainty of the nature of the buried components and the sensitivity of the materials that may remain in the disposal area is considered justification for performing a removal action at this site. While removal and control of the military items buried at the site is the focus of the planned removal action, the potential for soil contamination to be present that surrounds these items will also be addressed by this action. Additionally, elevated levels of polyaromatic hydrocarbons (PAHs) in soils and sediments will be addressed through isolated hot spot removals. Based on the results of the ecological mini-risk assessment, certain PAHs are a potential source of risk to ecological receptors.

The non-time-critical removal action that will be completed as a result of this Engineering Evaluation/Cost Analysis (EE/CA) and subsequent Action Memorandum, is intended to incorporate the necessary measures for removal site closeout. The outcome of this action will then be incorporated into the final Record of Decision (ROD) document. If following the risk assessment, unacceptable risk remains, additional remedial actions may be considered.

The overall objective of a removal action is to eliminate or reduce the threats to human health or to the environment. The primary threat from the soil and debris at this site is the potential for uncontrolled releases of hazardous constituents from the subsoils to the groundwater, especially since the debris is made up of various military components and drums, the nature of which is not fully known and could be sensitive or classified. The removal debris and possibly soils from the site is necessary for the protection of human health and the environment. In addition, minimal sediment removal will be performed to eliminate potential risk to ecological receptors.

The EE/CA is an evaluation of the removal action alternatives for a site. While similar to an RI/FS, it is less comprehensive. Section 1 of Appendix A (*EPA* PB89-184626, October 1988) compares the RI/FS and EE/CA process. The purpose of the EE/CA is to present the following:

- Assess the study area characteristics and justify the need for a removal action,
- Identify removal action objectives,
- Identify removal action technologies,
- Evaluate removal action technologies, and
- Propose a removal action that will achieve the removal action objectives.

Additionally, the EE/CA serves as a basis for the action memorandum and the design of the removal action. The action memorandum documents the need for a removal action and the decision process leading to a removal action.

The EE/CA and Action Memorandum for SEAD-63 is based on the findings in the *ESI Report for Low Priority AOCs - SEADs 60, 62, 63, 64 (A, B, C, and D), 67, 70, and 71* (Parsons ES, 1995a) and the *ESI Report for Three Moderately High Priority SWMUs* (Parsons ES, 1995b). Activities conducted as part of the ESI included: (1) seismic, electromagnetic and ground penetrating radar (GPR) surveys, as well as test pits, to determine groundwater flow direction and the exact location of the miscellaneous burial pits, (2) soil borings to gather stratigraphic information, (3) soil samples from borings and test pits for analytical testing, (4) construction and sampling of overburden groundwater monitoring wells, and (5) collection of surface water and sediment samples for analysis. Additional information for this EE/CA and Action Memorandum for SEAD-63 was obtained from the *Project Scoping Plan for Performing a CERCLA Remedial Investigation / Feasibility Study at SEAD-63 (Parsons, 1998).*

1.2 STATUTORY AUTHORITY

Authority for responding to releases or threats of releases from a hazardous waste site is addressed in section 104 of CERCLA, as amended. The Army has been delegated the response authority for Army sites, whether or not the sites are on the National Priorities List of the U.S. Environmental Protection Agency (EPA). Under CERCLA Section 104(b), the Army is authorized to investigate, survey, test, or gather other data required to identify the existence, extent, and nature of contaminants, including the extent of danger to human health or welfare and the environment. In addition, the Army is authorized to undertake planning, engineering, and other studies or investigations appropriate to directing response actions that prevent, limit, or mitigate the risk to human health or welfare and the environment.

1.3 SITE CONTACTS

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2.0 SITE CHARACTERIZATION

2.1 BASE DESCRIPTION AND HISTORY

This section provides a brief overview of SEDA and the conditions at the Miscellaneous Component Burial Site. The site was evaluated in 1994 as part of an Army effort to determine the conditions at several SWMUs that were considered to potentially pose a threat to human health and the environment. A more detailed discussion can be found in the draft Expanded Site Inspection Report for Seven Low Priority AOCs, SEADs 60, 62, 63, 64 (A, B, C, and D), 67, 70 and 71, April 1995.

The SEDA facility is situated on the western flank of a topographic high between Cayuga and Seneca lakes in the Finger Lakes region of central New York (**Figure 2-1**). Within the SEDA is the Miscellaneous Components Burial Site, located on the east side of North-South Baseline Road in the northwestern portion of the SEDA (**Figure 2-2**). The SEDA was constructed in 1941 and has been owned by the United States Government and operated by the Department of the Army since this time. The post generally consists of an elongated central area for storage of ammunitions and weaponry in quonset-style buildings, an operations and administration area in the eastern portion, and an army barracks area at the north end of the depot. The base was expanded to encompass a 1,524-meter airstrip, formerly the Sampson Air Force Base. The mission of the SEDA has been primarily the management of munitions. Currently, SEDA is used for the following purposes: 1) receiving, storing, and distributing ammunition and explosives, 2) providing receipt, storage, and distribution of items that support special weapons and 3) performing depot-level maintenance, demilitarization, and surveillance on conventional ammunition and special weapons. The depot formerly employed approximately 1,000 civilian and military personnel. Within the last year, the facility has undergone a downsizing and no longer houses a large contingent of military personnel.

The Miscellaneous Components Burial Site (SEAD-63) is approximately 480 by 300 feet and is bound by paved roads on the north, south, and west and by open grassland to the east (**Figure 2-3**). The site is mostly undeveloped except for a grass-covered bunker in the southeast corner and an elevated former machine-gun turret made of soil in the northwest corner. A noticeable feature of the site is a crushed shale road that enters the site via Patrol Road and leads to a crushed shale pad measuring about 100 by 100 feet. In general, the western half of the site is less vegetated and appears to have been physically worn by vehicular traffic.

Topography on-site is generally flat with only a small westward slope. Drainage ditches are adjacent to Patrol Road and the east-west trending roads that bound the site to the north and south. A light ground depression, sloping south to north, is located in the northeastern quadrant of the site. Reeder Creek is located approximately 1500 feet southwest of the site where it flows west into Seneca Lake. The site was used during the 1950s and 1960s as a disposal area for classified parts. Multiple disposal pits were excavated along a north-south line approximately 200 feet long. The individual pits were between 10 and 30 feet long and were likely to have been excavated down to the surface of the weathered shale. SEDA personnel have identified the types of materials disposed at this site as metal parts. The SWMU Classification Report states that "inert materials" were buried within the disposal pits.

The Expanded Site Inspection (ESI) field work conducted in 1994 (Parsons ES, 1995), provided further information on the nature and extent of contamination. Based on the conclusions of the ESI, a Remedial Investigation/Feasibility Study (RI/FS) was recommended and a portion of the field activities associated with the RI was performed. The results of the ESI and RI field work conducted are discussed below.

2.2 SITE-SPECIFIC GEOLOGY

Determination of the site geology was based on the drilling and test pit programs conducted for the ESI at SEAD-63. Fill material, till, weathered gray shale, and competent gray shale were the four major geologic units identified on-site. A thin topsoil layer (0.1 to 0.9 feet) was present at all three soil boring locations and 10 of the 12 test pit locations. The fill material was encountered in five test pits and drums were found in one test pit. Fill material thickness ranged from 0.6 feet to over 8 feet. The fill consisted of waste material with trace amounts of till, gravel sized shale fragments and sand. The waste material was comprised of miscellaneous military components.

The till was characterized as brown or olive gray silt and very fine sand with small (less than 1 inch) fragments of shale. Clay lenses were observed occasionally. Larger shale fragments, thought to be rip-up clasts, were encountered in some of the soil borings. The till was observed to be 5.0 to 6.9 feet thick in the three soil borings performed at SEAD-63.

The weathered shale that forms the transition between till and competent shale was observed in all three of the soil borings and ranged in thickness from approximately 1.3 to 3 feet.

Competent gray shale was observed in all three soil borings. The depths to bedrock ranged from 8.0 to 8.3 feet below ground surface. In all three soil borings, competent shale was inferred by auger refusal.

2.3 SITE-SPECIFIC HYDROLOGY AND HYDROGEOLOGY

Surface water flow from precipitation events is controlled by local topography and the drainage ditches along the northern, western, and southern boundaries of the site. As part of the ESI program, three monitoring wells were installed at SEAD-63. Groundwater elevations were measured in all three wells. Based on these data, the groundwater flow direction is primarily to the west and no appreciable changes in the groundwater flow direction were observed over the one month period from June 25, 1994 to July 26, 1994, when groundwater elevations were measured at SEAD-63.

2.4 LAND USE

The SEDA is situated between Seneca Lake and Cayuga Lake and encompasses portions of Romulus and Varick Townships. Land use in this region of New York is largely agricultural, with some forestry and public land (school, recreational and state parks). The most recent land use report is that issued by Cornell University (Cornell 1967). This report classifies in further detail land uses and environments of this region. Agricultural land use is categorized as inactive and active use. Inactive agricultural land consists of land committed to eventual forest regeneration, land waiting to be developed, or land presently under construction. Active agricultural land surrounding SEDA consists largely of cropland and cropland pasture.

Forest land adjacent to SEDA is primarily under regeneration with sporadic occurrence of mature forestry. Public and semi-public land use surrounding and within the vicinity of SEDA is Sampson State Park, Willard Psychiatric Center, and Central School (at the Town of Romulus). Sampson State Park entails approximately 1,853 acres of land and includes a boat ramp on Seneca Lake. Historically, Varick and Romulus Townships within Seneca County developed as an agricultural center supporting a rural population. However, increased population occurred in 1941 due to the opening of SEDA. Population has progressed since then largely due to the increased emphasis on promoting tourism and recreation in this area.

The 10,587-acre SEDA facility was constructed in 1941 and has been owned by the United States Government and operated by the Department of the Army (DOA) since that date. From its inception in 1941 until 1995, SEDA's primary mission was the receipt, storage, maintenance, and supply of military items, including munitions and equipment. The Depot's mission changed in early 1995 when the Department of Defense (DOD) recommended closure of the SEDA under its Base Realignment and Closure (BRAC) process. This recommendation was approved by Congress on September 28, 1995 and the Depot is scheduled for closure by July 2001.

In accordance with the requirements of the BRAC process, the Seneca County Board of Supervisors established the Seneca Army Depot Local Redevelopment Authority (LRA) in October 1995. The primary responsibility assigned to the LRA was to plan and oversee the redevelopment of the Depot. The Reuse Plan and Implementation Strategy for Seneca Army Depot was adopted by the LRA and approved by the Seneca County Board of Supervisors on October 22, 1996. Under this plan and subsequent amendment, areas within the Depot were classified as to their most likely future use. These areas included: housing, institutional, industrial, an area for the existing navigational LORAN transmitter, recreational/conservation and an area designated for a future prison. The LRA has established that the Q Area, which includes SEAD-63, will be used as a Wildlife Conservation Area. At the time when the SEDA facility is relinquished by the Army, the Army will ensure that SEAD-63 can be used for the intended purpose.

2.5 CONTAMINATION ASSESSMENT

Geophysical surveys and test pits were performed during the ESI to identify burial sites at SEAD-63. Soil, groundwater, surface water, and sediment were analyzed as part of the ESI conducted at SEAD-63 in 1994. The results of the ESI investigation were presented in the report titled "Expanded Site Inspection, Seven Low Priority AOCs, SEADs 60, 62, 63, 64 (A, B, C, and D), 67, 70 and 71", which was issued in April 1995. A total of 12 subsurface soil samples, 3 groundwater samples, and 4 surface water and sediment samples were collected as part of the ESI at SEAD-63. In addition, 18 surface water and sediment samples were collected in 1997 during the RI activities. The following sections describe the nature and extent of contamination identified at SEAD-63.

2.5.1 Geophysics

The seismic refraction profiles showed 6 to 9 feet of unconsolidated overburden (estimated at 1,600 ft/sec) overlying bedrock (11,200 to 13, 400 ft/sec). A compact, 3900 ft/sec. overburden layer was observed. Saturated overburden was not detected by the seismic survey. Due to inherent limitations of the seismic refraction method, a thin layer of saturated overburden (<2 feet) overlying the bedrock surface would be undetectable. The elevations of the bedrock surface, as determined by these surveys, indicate that the bedrock slopes to the west, generally following the surface topography. Groundwater flow is also expected to move to the west, following the slope of the bedrock.

An electromagnetic survey was performed at SEAD-63. A square shaped conductivity anomaly was detected in the northwest portion of the grid (see **Section 2** of **Appendix A**). This anomaly was correlated to the suspected miscellaneous components burial sites. The in-phase response of the EM-31 survey better defined the boundaries of the suspected burial pits; however, the square feature identified by the apparent conductivity survey was not detected. Additional EM-31 surveying was conducted during the RI field activities and confirmed the findings of the earlier survey.

The GPR survey conducted confirmed the findings of the EM survey.

2.5.2 Test Pitting Program

A total of twelve test pits were excavated in SEAD-63 to characterize the sources of the geophysical anomalies. Nine test pits were excavated in the area of suspected burial pits located by the in-phase response data and the GPR records from SEAD-63. Three test pits were excavated in the square shaped area of increased apparent ground conductivities identified by the EM-31 survey.

Miscellaneous military components were found in several of the test pits excavated in the area of the suspected burial pits. Each of these excavations was characterized by dark gray shale gravel fill overlying the burial pits. The base of the burial pits could not be determined in any of these five excavations due to the presence of a perched water layer within the buried materials. Components found in these test pits included battery assemblies, accelerometers, lock mechanisms, fire/safe pins, baroswitches, wiring, and quick connects. In one test pit, two drums were found buried in an upright position with their tops approximately one foot below grade. Both drums were in good condition and very little rust was noted on their surfaces. One of these drums had the words "BURIAL PIT" stenciled on its side. This drum was opened during the test pitting activities and electronics components were observed within it. No liquids were observed in the drum and all radiation and organic vapor field screening measurements that were taken around and within the drum had readings that were equal to background levels.

The excavated material was continuously screened for organic vapors with an OVM-580B and for radioactivity with a Victoreen-190 alpha-beta-gamma rate meter, a Ludlum-19 micro-R beta and gamma rate meter and a Ludlum 2221 alpha scintillometer. No readings above background levels (0 ppm for the OVM, 10-15 micro Rems per hour for the beta and gamma meters, and 6 counts per minute on the alpha meter) were observed during the excavations.

2.5.3 Radiological Survey

A radiological survey was conducted at SEAD-63 as part of the RI field investigation in September 1997. The survey was conducted using a PDR-77 and measured total counts per minute of low energy gamma radiation from the grounds of SEAD-63. As this area was classified as Class II, 50 percent of the grounds was covered by the survey as outlined in the RI/FS Project Scoping Plan for SEAD-12 and SEAD-63. The results of this survey did not indicate that there were any hot spot areas within the grounds of SEAD-63 that required further investigation or an upgrade in classification. All readings were within 50 percent of background levels. Typically, levels between 200 and 300 percent of background may indicate the need for additional surveying and investigation.

2.5.4 Summary of Affected Media

The results of the ESI and RI field work conducted at SEAD-63 indicate that past activities on site have had some impact on the soil quality. It is also possible that past activities on site may have impacted the groundwater and surface water quality, though the elevated chemical and radioanalysis results in the groundwater samples may be due solely to the high turbidity levels of those samples.

Miscellaneous military debris was found in several test pits on site. The extent of the former disposal pits on site were confirmed by geophysical surveys and the test pits conducted. The chemical and radiological impact on environmental media due to past activities on site is summarized below.

Soil

The soil analysis results indicate that soils are impacted by cadmium in several areas that were investigated by test pits during the ESI at SEAD-63. Cadmium concentrations in three test pit samples exceeded the TAGM value of 2.4 mg/kg by up to an order of magnitude. Mercury was detected in one test pit sample (TP63-3) at a concentration of 0.49 mg/kg. exceeding the TAGM value of 0.1 mg/kg. The average concentrations of both cadmium and mercury in SEAD-63 soils exceeded twice the average background concentration. **Figure 2-4** shows the locations and concentrations of cadmium in soil samples.

Based on a statistical comparison of radionuclide data from SEAD-63 and from background. the level of radionuclides from SEAD-63 are not distinguishable from background. Therefore. the soils at SEAD-63 do not exhibit a dose equivalent above the NYSDEC TAGM (10 mrem/yr above background).

Volatile organic compounds. semivolatile organic compounds. and pesticides were detected at low concentrations and only one semivolatile compound. dibenz(a.h)anthracene. was found at a concentration that exceeded its associated TAGM value. Dibenz(a.h)anthracene exceeded its TAGM value by 2 in one soil sample from TP63-9.

Groundwater

Radioactivity analysis results indicate that the groundwater in MW63-3 (located hydraulically downgradient of the disposal pits) may be impacted by gross alpha and gross beta radiation. The level of gross alpha radiation in this well was an order of magnitude above the NYS AWQS Class GA and federal drinking water criteria. In addition. gross alpha levels exceeded the NYS AWQS in MW63-1. which is considered to be the background location for the purpose of the ESI). Gross beta radiation levels detected in the groundwater samples collected from groundwater

3.2 THREATS TO THE ENVIRONMENT

An ecological mini-risk assessment was performed for SEAD-63 (see **Section 2** to **Appendix A**). The deer mouse, American robin, mourning dove, and the short-tailed shrew were considered as receptors. Only terrestrial receptors were considered in the ecological mini-risk assessment since there is no evidence of aquatic receptors at SEAD-63. Exposure to terrestrial receptors is from surface soils at the site and biota ingestion. Hazard quotients greater than one were calculated for all four receptors in relation to various constituents, seven total, indicating that the soils and sediments at SEAD-63 do currently pose a potential ecological risk.

3.3 STATUTORY AUTHORITY

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) states that a removal action may be conducted at a site when there is a potential threat to public health, public welfare, or the environment. An appropriate removal action is undertaken to abate, minimize, stabilize, mitigate, or eliminate the release or the threat of release at a site. Section 300.415(b)(2) of the NCP outlines factors to be considered when determining the appropriateness of a removal action, such as high levels of hazardous substances, pollutants, or contaminants in soils, largely at or near the surface, that may migrate; or the threat of fire or explosion.

Once it is determined that a removal action is appropriate, the removal is designated an emergency, time-critical, or non-time-critical removal. Emergencies are those situations in which response actions must begin within hours or days after the completion of the site evaluation. Time-critical removals are those in which, based on a site evaluation, it is determined that less than 6 months remains before response actions must begin. Non-time-critical removals are those in which it is determined that more than 6 months may pass before response actions must begin. Since more than 6 months may pass before this removal action begins, this removal action is considered a voluntary, non-time-critical removal action.

3.4 ADDITIONAL JUSTIFICATION FOR REMOVAL ACTION

When compared to ARARs and media-specific criteria, certain metals and organics exceed their respective criteria in all media. However, the results of the mini-risk assessment show that risk based on current conditions at SEAD-63 is within acceptable limits for the most likely future use scenarios. Radionuclides in sediment and surface water are elevated when compared to background

3.0 THREATS TO PUBLIC HEALTH, WELFARE OR THE ENVIRONMENT: STATUTORY AND REGULATORY AUTHORITIES

The removal action program discussed in this action memorandum is proposed to address the potential threats discussed below.

3.1 THREATS TO PUBLIC HEALTH OR WELFARE

A streamlined risk assessment (or mini-risk assessment) was conducted to determine the extent of human risk posed by the contaminants present at SEAD-63 (see **Section 2** of **Appendix A**). Likely receptors included a park worker, construction worker, and recreational visitor (child). A residential receptor was also considered for comparative purposes only. Future residential use of the land is highly unlikely. Except for groundwater and surface water exposure under the residential scenario, risks for the recreational child, park worker, and construction worker are acceptable (HI less than 1 and carcinogenic risk less than $1x10^{-4}$). The recreational child resulted in a hazard index of 0.4 and the lifetime cancer risk for an adult is 8×10^{-5}. The park worker resulted in a hazard index of 0.2 and a cancer risk of 5×10^{-5}. The primary constituents driving the cancer risks for recreational child and parker worker are dibenz(a,h)anthracene and benzo(a)pyrene in surface water. These two constituents were only detected in one out of 22 samples. Therefore, risk driven by these two constituents is most likely significantly lower than indicated by the mini-risk assessment; the likelihood of a residential receptor spending all of his/her exposure time at the one location where the detection was made is highly unlikely. Under the construction worker scenario, the hazard index is 0.3 and the cancer risk is 9×10^{-8}. The primary driver for noncarcinogenic risk is exposure to cadmium in soils. Mercury, which was also detected above background levels, did not contribute significantly to risk.

The residential scenario, which was considered for comparative purposes only, exhibited the greatest noncarcinogenic risk for a residential child (HI=2). This was primarily due to the presence of manganese in groundwater. As there is no source of manganese at SEAD-63 (soil concentrations of manganese did not exceed background levels), its presence in the groundwater is suspect and may be due to turbidity in the three groundwater samples collected from the site. The collection of additional groundwater data is recommended for this site. Carcinogenic risk is 1×10^{-4}, which is mainly caused by exposure to dibenz(a,h)anthracene and benzo(a)pyrene in surface water.

levels in these media. However, sediment does not exhibit a dose equivalent above background greater than the NYSDEC TAGM and no surface water criteria have been established for radionuclides. ARARs for gross alpha in groundwater are exceeded in two groundwater samples. The source of the elevated levels of these compounds requires further investigation that will be incorporated as part of this removal action.

Although heavy metals are present in the soils surrounding the buried miscellaneous military items above background levels and the NYSDEC TAGMs, the mini-risk assessment described in **Section 2 of Appendix A** does not demonstrate unacceptable risk from the metals in the soil at this site. However, the investigation has confirmed the presence of various military components. The presence of such buried objects, including buried drums, is of concern, since the nature of the drum contents are unknown and could potentially pose considerable risk. Furthermore, some buried components deposited at SEAD-63 may still be classified or sensitive and would need to be examined by appropriate military personnel for evaluation and declassification. The potential risk resulting from the uncertainty of the nature of the buried components and the sensitivity of the materials that may remain in the disposal area is considered justification for performing a removal action at this site. While removal and control of the military items buried at the site is the focus of the planned removal action, the potential for soil contamination to be present that surrounds these items will also be addressed by this action. Goals for allowable soil concentrations, in particular for cadmium, will be developed, based upon existing conditions, and will be used as the basis for returning soil, segregated from the military items, to the excavation pit.

4.0 ENDANGERMENT DETERMINATION

Actual or threatened releases of pollutants and contaminants from this site as a result of the Military unique hardware and buried drums (the content of which is unknown, if not addressed by implementing the response action selected in this action memorandum, may present an endangerment to public health, welfare, or the environment.

top two feet of the investigation pit. During the excavation, the walls of the excavation will be sloped to assure their stability, in accordance with the levels required by OSHA. Alternate techniques may also be used to provide excavation stability. Groundwater inflow may be controlled by trench de-watering or with a sump pump within the excavation. Any groundwater collected will be treated and disposed in accordance with all state and federal regulations. **Figure 5-2** shows the decision making process for disposal of debris/soil from SEAD-63. The off-site disposal location for debris is dependent on radiological screening results and whether or not the debris is classified. Non-classified, non-radiological debris is proposed for disposal at a non-hazardous landfill. If debris is a source of radionuclides, debris will be disposed at a facility permitted to accept such debris. Soil will be sampled for metals (in particular cadmium and mercury) and radionuclides. It is anticipated that soils will not exceed clean up criteria, and in that case, may be used to backfill the site. However, off-site disposal of soil will be required, according to the nature of the soils, if this is not the case.

Sediment will be excavated from the drainage ditches associated with the referenced locations. The excavation will be to a depth of depth of 6 inches, extending to the width of the drainage (up to 6 feet) and 25 feet up- and down-gradient from each location. Where two sediment locations are adjacent, the excavation will be continuous between the locations.

In addition to the proposed removal action, up to four new groundwater wells will be installed in the area of SEAD-63 and another round of groundwater samples will be collected from the existing wells and the new wells to characterize the quality of the groundwater present at the site. This round of sampling will be completed using low-flow purge-and-pump techniques to reduce the levels of turbidity associated with recovered groundwater samples. Reduction of turbidity will, hopefully, also result in a reduction of metals and radiological constituent content found in the groundwater of the area.

5.1.3 Contribution to Remedial Performance

The purpose of this action is to remove the debris at the site and thereby reduce the potential for further contamination of soils and groundwater. Because the impetus for the removal action at this site is the presence of debris, and due to the uncertain nature of these buried drums and military components, excavation and disposal, rather than any sort of in situ treatment of these items is logical. For this reason, no alternative technologies were evaluated as part of this evaluation.

5.0 PROPOSED ACTIONS AND ESTIMATED COSTS

5.1 PROPOSED ACTIONS

5.1.1 General Statement of the Removal Action Objectives

The establishment of action objectives and site-specific considerations forms a basis for identifying and selecting appropriate action alternatives. Action objectives must:

- Protect human health and the environment, and
- Address contaminants of concern, exposure routes, and receptors.

Applicable or relevant and appropriate requirements (ARARs) establish cleanup standards that can be used to define action objectives.

Several general objectives can be defined for the proposed action at the SEAD-63. The primary objective is to eliminate the threat of possible soils, sediment, and groundwater contamination by removing the source of the contamination (i.e. debris and sediment). Secondary objectives include completing all remedial activities on site, in a manner which minimizes exposure to workers and the general public during the remedial activities.

5.1.2 Proposed Action Description

Once the work plans have been approved, site preparation and mobilization will begin. The contractor will bring all the necessary equipment to the site, arrange for all required utilities, and obtain all necessary permits. If necessary, pads will be constructed for the equipment, and run on and run off controls will be constructed. Approximately 4,500 cubic yards of debris, including military components and drums, and soil will be excavated from the disposal area (EM anomaly). In addition, approximately 100 cubic yards of sediment removed from locations exceeding the sediment guidelines (locations SWSD63-3, SWSD63-10, SWSD63-11, SWSD63-14, SWSD63-18, SWSD63-19, and SWSD63-4). The excavation locations are presented on **Figure 5-1.**

Approximately 4,540 cubic yards of material will be excavated from the disposal area, with the average excavation depth estimated to be five feet. Based on the test pitting investigation, debris was observed at greater than eight feet in some areas, while other areas found debris only within the

Detailed requirements include sampling and analytical protocols. The broader aspects will address the procedures necessary to ensure that the excavation, sizing, and stabilization procedures are conducted for accordance with the specifications. The removal action does not propose any debris washing or wet screening, liquid wastes will be limited to water associated with dewatering the excavations and decontamination water. These liquid wastes will be accumulated separately and classified for appropriate disposal.

Additional QA/QC will be provided by a third-party oversight contractor. The oversight contractor will be responsible for monitoring the removal action activities, radiation scanning, and collection of confirmation soil samples for chemical and radiological requirements. The QA/QC plan will be provided as part of the Removal Action Work Plan.

5.2 ARARS STANDARDS, CRITERIA AND GUIDELINES (SCGS)

Pursuant to Section 300.415(i) of the NCP, the removal action for the site "shall, to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws." ARARs are used to identify removal action objectives, formulate removal action alternatives, govern the implementation and operation of a selected removal action, and evaluate the appropriate extent of site cleanup.

In 40 CFR 300.5, EPA defines applicable requirements as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are defined as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

5.1.4 Engineering Evaluation/Cost Analysis

In order to determine the appropriate remedial technology for the SEAD-63, an EE/CA was conducted. The EE/CA is included as **Appendix A** of this report. The EE/CA contains a brief summary of the site history and the results of previous investigations.

5.1.5 Description of Alternative Technologies

The main focus of the EE/CA is an evaluation of the different remedial technologies. Because the impetus for the removal action at this site is the presence of debris, and due to the uncertain nature of these buried drums and military components, only one alternative, excavation and disposal, rather than any sort of in situ treatment of these items is logical. For this reason, no alternative technologies were evaluated as part of this evaluation.

5.1.6 Institutional Controls

There are no institutional controls required for this action. The requirement for institutional controls will be addressed as part of the overall remedial action.

5.1.7 Off-Site Disposal Policy

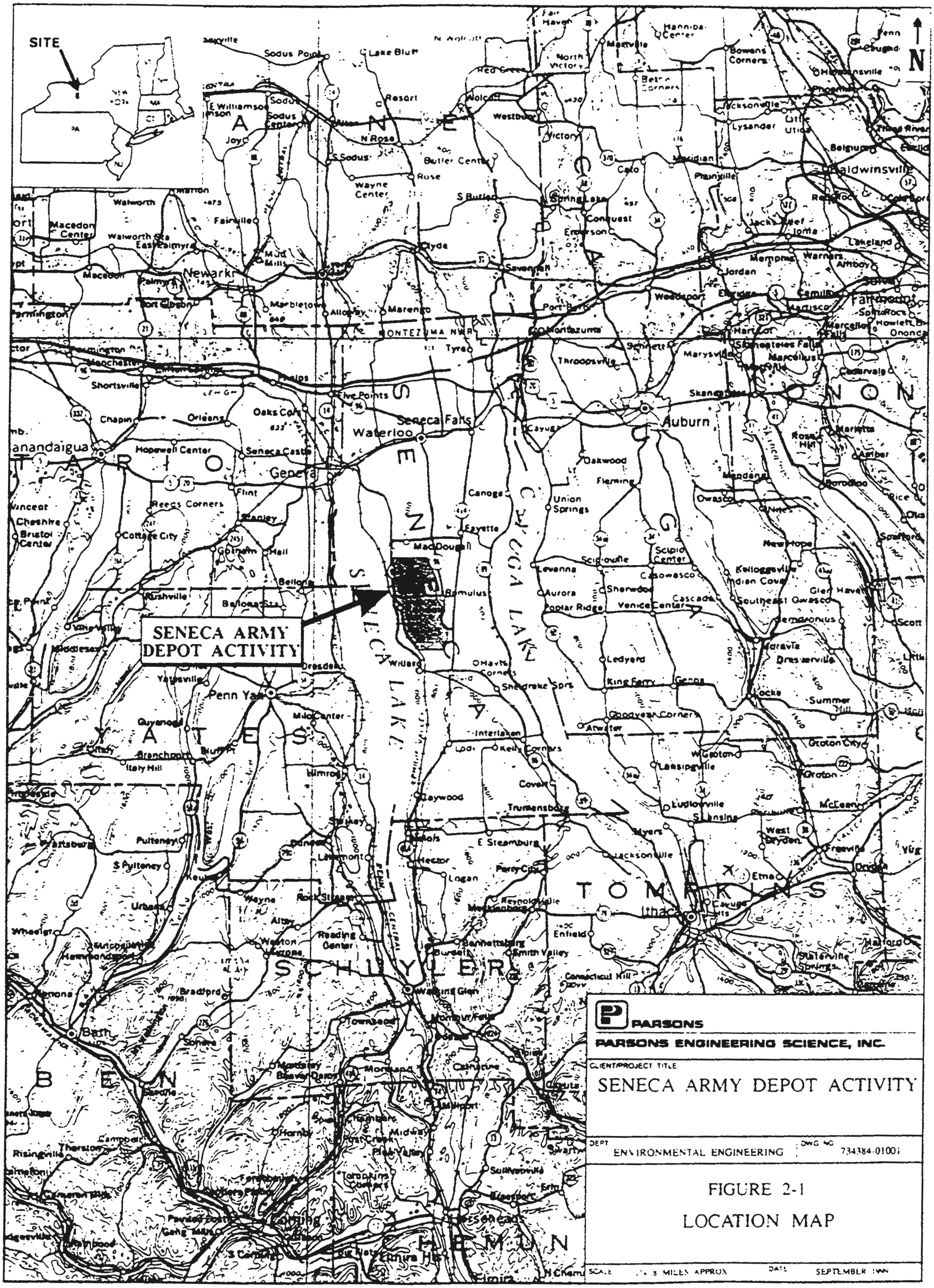
It is anticipated that no materials classified as hazardous waste will be generated during this removal action. All non-hazardous, non-radiological waste (construction debris, etc.) will be disposed in an approved non-hazardous waste landfill (if necessary). Envirocare in Clive, UT is proposed as the destination for any radiological containing debris or soils exhibiting radionuclides greater than clean up goals. Envirocare accepts low level radiological wastes and soils.

5.1.8 Post-Removal Site Control Activities

The depot is fenced and patrolled by armed guards to limit access.

5.1.9 QA/QC Plan

The removal contractor will be required to develop a QA/QC plan which will be submitted to the appropriate agencies for approval. This plan will address both detailed and broad QA/QC issues.



PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY

DEPT ENVIRONMENTAL ENGINEERING

DWG NO 734384-01001

FIGURE 2-1

LOCATION MAP

SCALE 1" = 8 MILES APPROX

DATE SEPTEMBER [illegible]

R:\GRAPHICS\SENECA\LOCMAP.CDR(CVM)

9.0 RECOMMENDATION

The action recommended for SEAD-63 is excavation of the debris and possibly soils, limited excavation of sediments, off-site disposal of debris, including buried drums and Military hardware that must be removed, and if constituents present in soil are below clean up criteria, backfilling of excavated soils and sediments on-site. Additionally, up to four new monitoring wells will be installed near SEAD-63 for use in the characterization of underlying groundwater. The new wells, and the three existing site wells, will be sampled using low-flow purge-and-pump techniques to minimize turbidity levels, and the collected samples analyzed to determine if the noted elevated levels of metals and gross alpha and gross beta radiation are related to the high turbidity levels present in the original samples.

This action memorandum represents the selected removal action for SEAD-63 at the Seneca Army Depot located in Romulus, New York. This proposal was developed in accordance with CERCLA as amended, and consistent with the NCP.

8.0 ENFORCEMENT

This section is not applicable to this removal action since the lead agency, the Army is the Principle Responsible Party for this site, and is taking responsibility for the removal action.

7.0 OUTSTANDING POLICY ISSUES

This section is not applicable to this removal action since the lead agency for this site is the Army, and not the EPA, NYSDEC, or NYSDOH.

6.0 EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

If this removal action is delayed or not taken, several changes in site conditions may occur:

- Further contamination of soils and groundwater could occur in areas surrounding the buried drums and miscellaneous Military components, since the composition and contents of these items are not fully known and could be a possible source of contamination.

- Some lateral and vertical migration of the contaminants can be expected. The migration could occur through several mechanisms, including transport of water-soluble constituents through infiltration or runoff.

- The contamination in the soil is likely to migrate slowly over time. Contaminants that are near or at the water table may be transported via leaching and groundwater flow.

conducted to demonstrate compliance with dose-based regulations (e.g. the NYSDEC TAGM of 10 mrem/yr). If the null hypothesis established in MARSSIM is rejected (i.e. the median concentration in the survey unit exceeds the reference area by more than the DCGL), then acceptable clean up goals have been achieved. The DCGLs shown in **Table 5-1** are considered preliminary since their application depends on which radionuclides are distinguishable from background during confirmatory sampling and what area is actually affected by those radionuclides.

In addition to the above analysis, a DCGL for elevated measurement comparison ($DCGL_{EMC}$) will be derived and used to compare each data point from the confirmatory sampling to ensure that no single data point indicates the presence of a hot spot. The $DCGL_{EMC}$ will be derived by decreasing the affected area used in RESRAD in deriving the DCGL to account for the largest area that may be missed by the sampling grid used to perform the final status survey. MARSSIM discusses the derivation and use of the $DCGL_{EMC}$ in Section 8.5.1 of MARSSIM.

5.3.3 Discharge Criteria for Groundwater

Proposed discharge criteria for groundwater or surface water generated during the removal action (e.g. dewatering operations) are provided in **Table 5-3**. These criteria are consistent with requirements defined in 6 NYCRR Part 380 and based on radiation dose limits for individual members of the public. Discharge criteria for non-radiogenic constituents will be adopted based on values as reported in the Division of Water Technical and Operational Guidance Series (1.1.1 and 1.1.2) (TOGS) for Ambient Water Quality Standards And Guidance Values And Groundwater Effluent Limitations. This document includes the groundwater standards (6 NYCRR 703.5) and regulatory effluent limitations (6 NYCRR 703.6).

5.4 PROJECT SCHEDULE

The total duration for the removal action after regulatory approval is 2 months.

5.5 ESTIMATED COSTS

The estimated present worth project cost of $ 1,090,000 is based upon a preliminary estimate provided by Parsons Engineering Science, using the TRACES/MCACES for Windows v1.2 software.

The ESI data indicate that radionuclides are not present in the soil above background levels. However, in the event that confirmatory sampling performed in support of the final status survey indicates the presence of radionuclides above background levels, site specific clean up goals will be established using RESRAD. The RESRAD model uses dose assessment methodology to derive site-specific soil guidelines. These guidelines, referred to as DCGLs (derived concentration guideline levels) in MARSSIM, will be used as described in MARSSIM to determine if the site may be released for unrestricted use. Preliminary guidelines have been established using RESRAD and site specific information for SEAD-63. These guidelines were derived based on an exterior dose limit of 10 mrem per year above background (NYSDEC TAGM). This dose limit was input into RESRAD to obtain a dose derived guideline level (DCGL) that is expressed in the same units as the final radiological survey soil data (i.e., pCi/g). The RESRAD model uses dose assessment methodology recommended for use in deriving site-specific soil guidelines. Using the permissible dose limit, RESRAD was run to calculate site specific DCGLs for each radionuclide potentially present at SEAD-63. The DCGL derived is the maximum concentration of the radionuclide above background that would yield the permissible dose limit if it were the only radionuclide present. This value is independent of the concentration of radionuclides found at SEAD-63, but is dependent on the exposure scenario. DCGLs were calculated using RESRAD for three the human receptors, the park worker, construction worker, and recreational child. DCGLs were also derived for a residential scenario for comparison purposes only, since such a receptor is highly unlikely under the planned future land use of the site. Soil clean-up guidelines for SEAD-63 (shown in **Table 5-1**) will be set at the lowest DCGLs calculated for any of the three likely future use scenarios. Assumptions and input values used in RESRAD to derive these guidelines, as well as model output are presented in **Appendix E**.

The preliminary DCGLs presented in **Table 5-1** would be used in the following manner to establish final DCGLs. Data collected from remaining soils at SEAD-63 after site remediation would be used in the following manner. Radionuclides distinguishable from background will be identified. The activity fraction of each radionuclide above background will be calculated by dividing the average activity of a single radionuclide by the sum of the average activities of all radionuclides distinguishable from background. This fraction, f, will then be multiplied by the DCGL shown in **Table 5-1** to determine the radionuclide specific DCGL that contributes to the total dose. This DCGL will be added to the site background soil data set (given in **Appendix D**), and used to compare the site data set by running the Wilcoxon Rank Sum test, as described in Section 8.4.1 of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). MARSSIM provides guidance for planning and evaluating environmental radiological surveys

5.3 SITE-SPECIFIC CLEAN-UP GOALS

Site specific clean-up goals for chemicals and radionuclides of concern are discussed below.

5.3.1 Clean-Up Goals for Non-Radionuclides of Concern in Soil

Cadmium is the only metallic constituent of concern in soil at SEAD-63. **Table 5-1** presents the site clean-up goals established for soil remediation at SEAD-63. The clean up goals shown in **Table 5-1** were developed based on the streamlined risk evaluation results presented in **Section 2 of Appendix F**. and on the assumption that all constituents existing at the site other than cadmium remain at their present levels. The 50 mg/kg goal represents the highest concentrations of cadmium that could exist at the site, all other constituents being present at their current levels, and still result in acceptable human and ecological risk (i.e., $HQ<1$, carcinogenic risk $< 1\times10^{-4}$, and $EQ<1$). Supporting risk calculations are provided in **Appendix F**.

5.3.2 Clean-Up Goals for Radionuclides of Concern in Soil

Soil samples will be collected from the site after the removal action has been performed in support of a final status survey. The final status survey will be conducted to demonstrate compliance with the release criterion. The NYSDEC TAGM of 10 mrem/yr above background for unrestricted use is the goal set for the release criterion. The final status survey will be performed in accordance with the Multi-Agency Survey and Site Investigation Manual (MARSSIM) for a Class 2 area, which is the area designation given to SEAD-63 in the SEAD-12 and SEAD-63 Project Scoping Plan (June 1998). **Table 5-2** presents the radionuclides of concern based on military items potentially handled at the site.

- Clean Water Act. - NPDES Permitting Requirements for Discharge of Treatment System Effluent (40 CFR 122-125).

- Effluent Guidelines for Organic Chemicals. Plastics and Resins (Discharge Limits) (40 CFR 414).
- Clean Water Act Discharge to Publicly - Owned Treatment Works (POTW) (40 CFR 403).

- DOT Rules for Hazardous Materials Transport (49 CFR 107. 171.1-171.500).

- Occupational Safety and Health Standards for Hazardous Responses and General Construction Activities (29 CFR 1904. 1910. 1926).

- SARA (42 USC 9601)

- OSHA (29 CFR 1910.120)

- Clean Air Act (40 CFR 50.61)

New York State:

- New York State Pollution Discharge Elimination System (SPDES) Requirements (Standards for Stormwater Runoff. Surface water. and Groundwater discharges (6 NYCRR 750-757).

- New York State RCRA Standards for the Design and Operation of Hazardous Waste Treatment Facilities (i.e.. landfills. incinerators. tanks. containers. etc.): Minimum Technology Requirements (6 NYCRR 370-373).

- New York State RCRA Closure and Post-Closure Standards (Clean Closure and Waste-in-Place Closures) (6 NYCRR 372).

- New York State Solid Waste Management Requirements and Siting Restrictions (6 NYCRR 360-361). and revisions/enhancements effective October 9. 1993.

- New York State RCRA Generator and Transporter Requirements for Manifesting Waste for Off-Site Disposal (6 NYCRR 364 and 372).

- Endangered and Threatened Species of Fish and Wildlife Requirements (6 NYCRR 182).
- New York State Flood Hazard Area Construction Standards.

5.2.3 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based- limitations that control actions at hazardous waste sites. Action-specific ARARs generally set performance or design standards, controls, or restrictions on particular types of activities. To develop technically feasible alternatives, applicable performance or design standards must be considered during the development of all removal alternatives. Action-specific ARARs are applicable to this site. The action-specific ARARs to be used will be determined by the Army based upon the technology chosen. Federal and State regulations that may apply include the following:

Federal:

- RCRA Subtitle C Hazardous Waste Treatment Facility Design and Operating Standards for Treatment and Disposal systems, (i.e., landfill, incinerators, tanks, containers, etc.) (40 CFR 264 and 265); Minimum Technology Requirements.
- RCRA, Subtitle C, Closure and Post-Closure Standards (40 CFR 264, Subpart G).
- RCRA Groundwater Monitoring and Protection Standards (40 CFR, Subpart F).
- RCRA Generator Requirements for Manifesting Waste for Off-site Disposal (40 CFR 262).
- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 263).
- RCRA, Subtitle D, Non-Hazardous Waste Management Standards (40 CFR 257).
- Safe Drinking Water Act, Underground Injection Control Requirements (40 CFR 144 and 146).
- RCRA Land Disposal Restrictions (40 CFR 268) (On and off-site disposal of excavated soil).

- Wetlands Construction and Management Procedures (40 CFR 6. Appendix A).
- USDA/SCS - Farmland Protection Policy (7CFR 658)
- USDA Secretary's memorandum No. 1827. Supplement 1, Statement of Prime Farmland, and Forest Land - June 21. 1976.
- EPA Statement of Policy to Protect Environmentally Significant Agricultural Lands - September 8. 1978.
- Farmland Protection Policy Act of 1981 (FPPA)(7 USC 4201 et seq).
- Endangered Species Act (16 USC 1531).
- Fish and Wildlife Coordination Act (16 USC 661)
- Wilderness Act (16 USC 1131).

New York State:

- New York State Freshwater Wetlands Law (ECL Article 24. 71 in Title 23).
- New York State Freshwater Wetlands Permit Requirements and Classification (6 NYCRR 663 and 664).
- New York State Floodplain Management Act and Regulations (ECL Article 36 and 6 NYCRR 500).

- Declaration of Policy, Article 1 Environmental Conservation Law (ECL)

- General Functions, Powers, Duties and Jurisdiction, Article 3 Environmental Conservation Law, Department of Environmental Conservation

- ECL, Protection of Water, Article 15, Title 5.

- Use and Protection of Waters, (6 NYCRR, Part 608)

- New York State Title 12, Part 38, Ionizing Radiation Protection, Acceptable Surface Contamination Levels (12 NYCRR Part 38)

5.2.2 Location-Specific ARARs

Location-specific ARARs govern natural site features such as wetlands, floodplains, and sensitive ecosystems, and manmade features such as landfills, disposal areas, and places of historic or archaeological significance. These ARARs generally restrict the concentration of hazardous substances or the conduct of activities based solely on the particular characteristics or location of the site. Federal and State regulations that may apply to this removal action include the following:

Federal:

- Executive Orders on Floodplain Management and Wetlands Protection (CERCLA Floodplain and Wetlands Assessments) #11988 and 11990

- National Historic Preservation Act (16 USC 470) Section 106 et seq. (36 CFR 800) (Requires Federal agencies to identify all affected properties on or eligible for the National Register of Historic Places and consult with the State Historic Preservation Office and Advisory Council on Historic Presentation)

- RCRA Location Requirements for 100-year Floodplains (40 CFR 264.18(b)).

- Clean Water Act, Section 404, and Rivers and Harbor Act, Section 10, Requirements for Dredge and Fill Activities (40 CFR 230)

- Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (40 CFR 141.11-.16)

New York State:

- New York State Codes, Rules and Regulations (NYCRR) Title 6, Chapter X
- New York Groundwater Quality Standards (6 NYCRR 703)
- New York Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (10 NYCRR 5)
- New York Surface Water Quality Standards (6 NYCRR 702)
- New York State Raw Water Quality Standards (10 NYCRR 170.4)
- New York RCRA Groundwater Protection Standards (6 NYCRR 373-2.6 (e))
- New York State Department of Environmental Conservation, Division of Water, Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values, November 15, 1990
- New York State Department of Environmental Conservation, Division of Hazardous Substances Regulation, Technical and Operational Guidance Series, Technical Administrative Guidance Memorandum: 4003, Cleanup Guideline for Soils Contaminated with Radioactive Materials (TAGM 4003).
- New York State Department of Environmental Conservation, Division of Hazardous Waste Remediation, Technical and Operational Guidance Series, Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels, HWR-94-4046 (TAGM 4046).
- New York State Department of Environment Conservation, Division of Fish and Wildlife, Division of Marine Resources, Technical Guidance for Screening Contaminated Sediments, July 1994.
- Surface Water and Groundwater Classifications and Standards (6 NYCRR 700-705)

Any standard, requirement, criterion, or limitation under any federal environmental or state environmental or facility siting law may be either applicable or relevant and appropriate to a specific action. The only state laws that may become ARARs are those promulgated such that they are legally enforceable and generally applicable and equivalent to or more stringent than federal laws. A determination of applicability is made for the requirements as a whole, whereas a determination of relevance and appropriateness may be made for only specific portions of a requirement. An action must comply with relevant and appropriate requirements to the same extent as an applicable requirement with regard to substantive conditions, but need not comply with the administrative conditions of the requirement.

Three categories of ARARs have been analyzed: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs address certain chemicals or a class of chemicals and relate to the level of contamination allowed for a specific pollutant in various environmental media (water, soil, and air). Location-specific ARARs are based on the specific setting and nature of the site. Action-specific ARARs relate to specific actions proposed for implementation at a site.

5.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are usually health or risk-based standards limiting the concentration of a chemical found in or discharged to the environment. They govern the extent of site remediation by providing actual cleanup levels, or the basis for calculating such levels for specific media. These requirements may apply to air emissions during the removal action. A number of federal and state regulations may be used for this site. These include the following:

Federal:

- Resource Conservation and Recovery Act (RCRA), Groundwater Protection Standards and Maximum Concentration Limits (40 CFR 264, Subpart F)
- Atomic Energy Act, Standards for Protection Against Radiation (10 CFR 20 subpart D)
- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book)
- Clean Air Act, Standards for Radionuclides (40 CFR 61.22 and .102)

monitoring wells MW63-3 and MW63-1 may be similarly impacted, though the elevated gross beta levels may be due to the high NTUs of those groundwater samples. The NYS AWQS for gross beta was not exceeded.

Other constituents that were detected include one semivolatile organic compound and metals. Phenol was detected at a concentration of 2J mg/L, exceeding its criteria value of 1 mg/L. Iron and manganese were detected above their criteria in all of the groundwater samples collected at SEAD-63.

Surface Water

Surface water at SEAD-63 has been impacted by SVOCs (primarily phthalates). Two SVOCs were detected at levels exceeding the NYS AWQS. In addition, aluminum, cobalt, iron, lead and silver were detected above their respective NYS AWQS.

Radionuclides present in background surface water locations were detected in the surface waters at SEAD-63. In addition, Co-60, Ra-226, Th-230, and U-233/234 were also detected at SEAD-63. The maximum and average values of the radionuclides detected at SEAD-63 were greater than the maximum and average background concentrations. Gross alpha and gross beta levels were significantly greater at SEAD-63 in at least one surface water location (SW63-2) than at background locations. However, the elevated levels at SW63-2 may be due to the high turbidity of this sample. Statistical comparison of the SEAD-63 and background data sets indicate that Ac-227, Radon 222, tritium, U-235, and U-238 are elevated above background. There are no NYS Ambient Water Quality Standards for radionuclides in Class C surface waters.

Sediment

Sediment at the site has been impacted by semivolatile organic compounds (mostly PAHs) and pesticides. The PAHs benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene, and indeno(1,2,3-cd) pyrene were detected at concentrations which exceeded the NYSDEC criteria value of 1.3 mg/kg by 2 to 3 times. No pesticides/PCBs were detected at levels greater than NYSDEC sediment criteria. Copper, manganese, nickel, and zinc were detected at concentrations at least twice their respective criteria values.

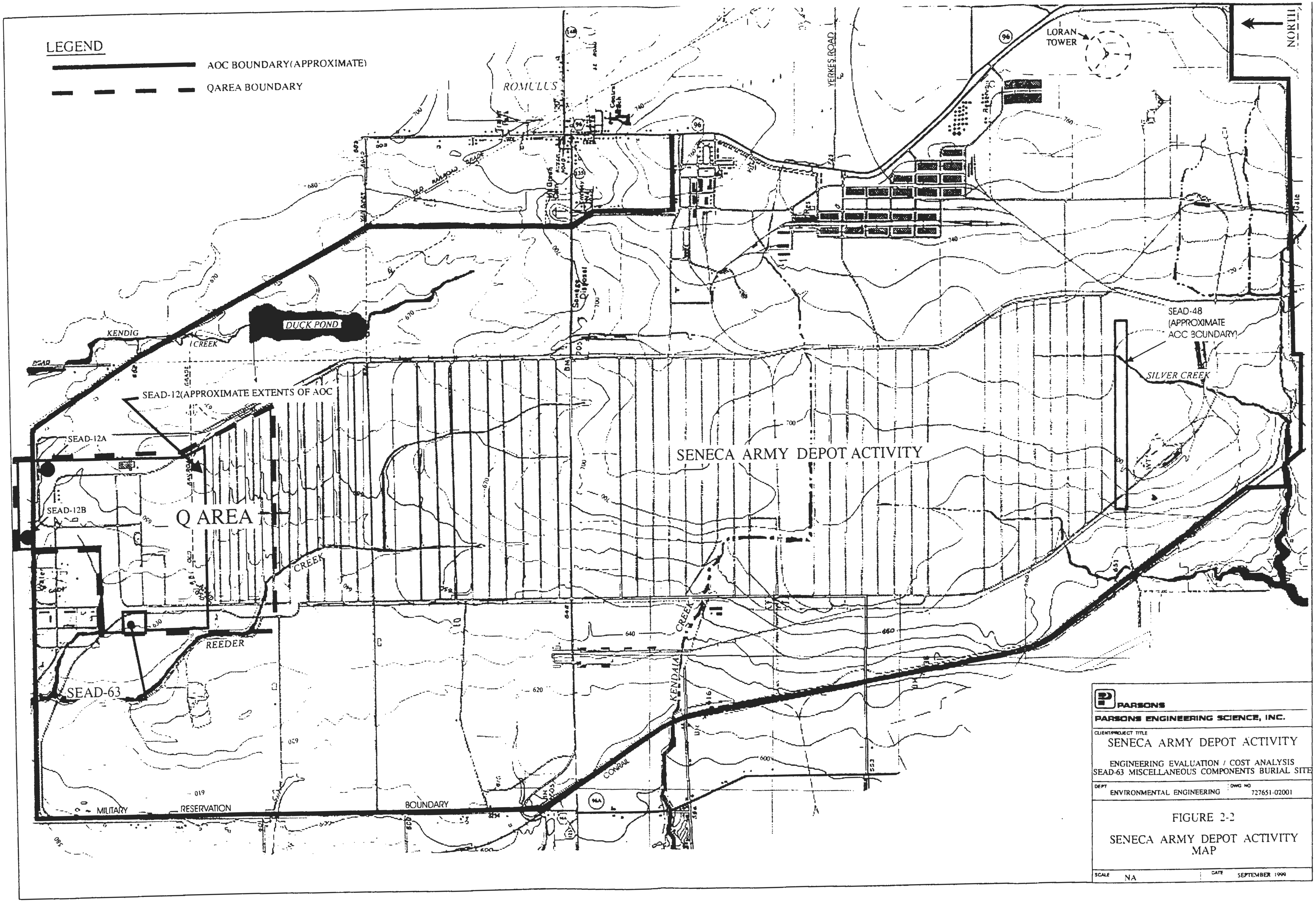
All radionuclides detected at SEAD-63, except for Pb-210, were also found in background sediment samples collected. Although the maximum values detected in the SEAD-63 samples exceeded the maximum values of the background samples, average values were comparable. Wilcoxon rank sum tests indicated that Cs-137, Th-230, U-233/234 and U-238 were elevated above background levels. No NYSDEC sediment criteria exist for these radionuclides. However, in comparison to the NYSDEC TAGM Cleanup Guideline for Soils Contaminated with Radioactive Material, radionuclides distinguishable from background in the sediment do not exhibit a dose equivalent greater than the 10 mrem/yr cleanup guideline based on RESRAD modeling.

2.6 STATE AND LOCAL ACTIONS TO DATE

There have been no related state or local actions to date at the SEAD-63.

2.7 POTENTIAL FOR CONTINUED STATE/LOCAL RESPONSE

There are no known plans for state or local response at the site. The removal action proposed in this action memorandum will be conducted by the Army. State authorities will continue to be given the opportunity to review and comment on site documents. State authorities may also conduct confirmatory sampling upon completion of the removal action.



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CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY

ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT ENVIRONMENTAL ENGINEERING

DWG NO 727651-02001

FIGURE 2-2

SENECA ARMY DEPOT ACTIVITY
MAP

SCALE NA

DATE SEPTEMBER 1999

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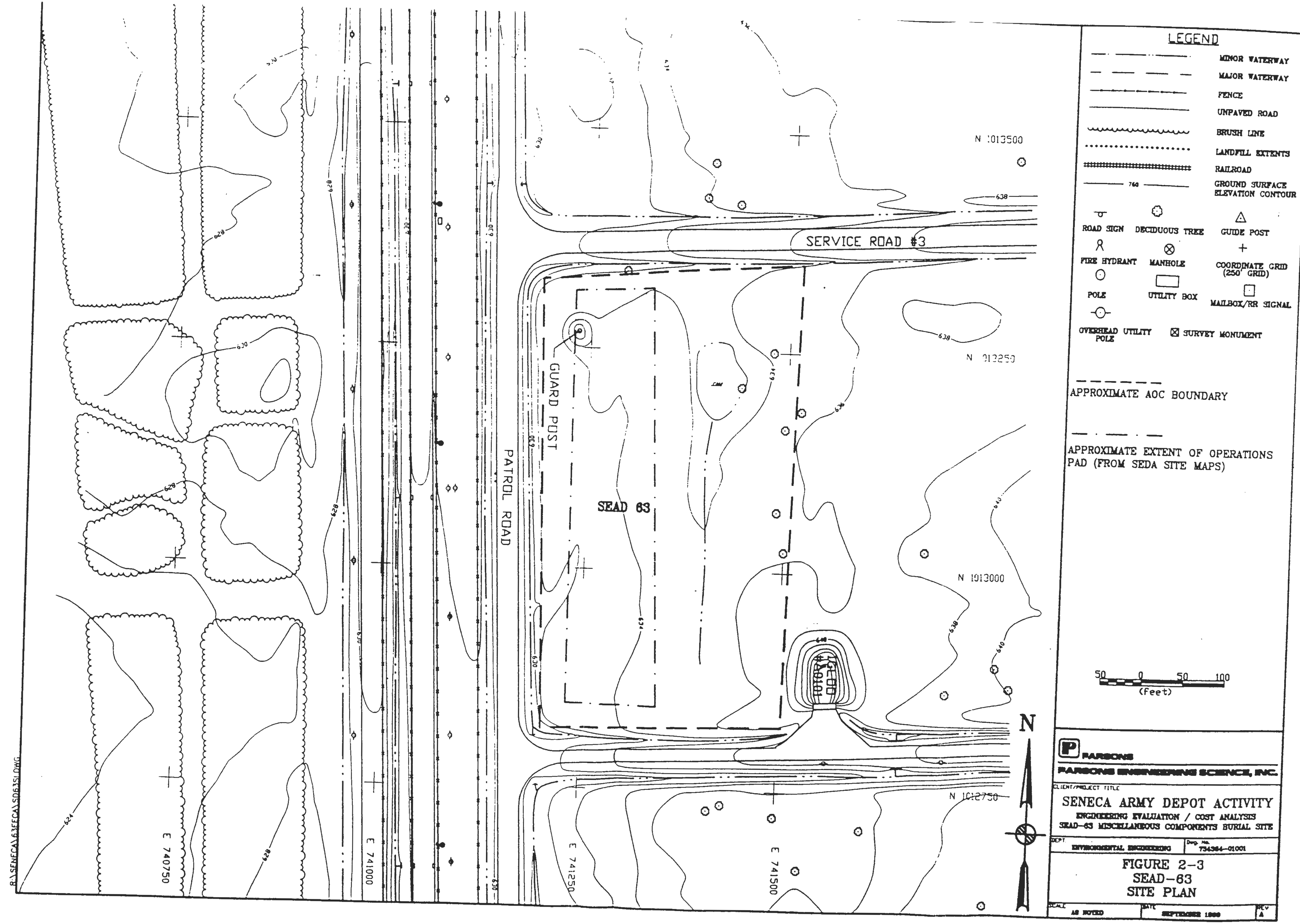

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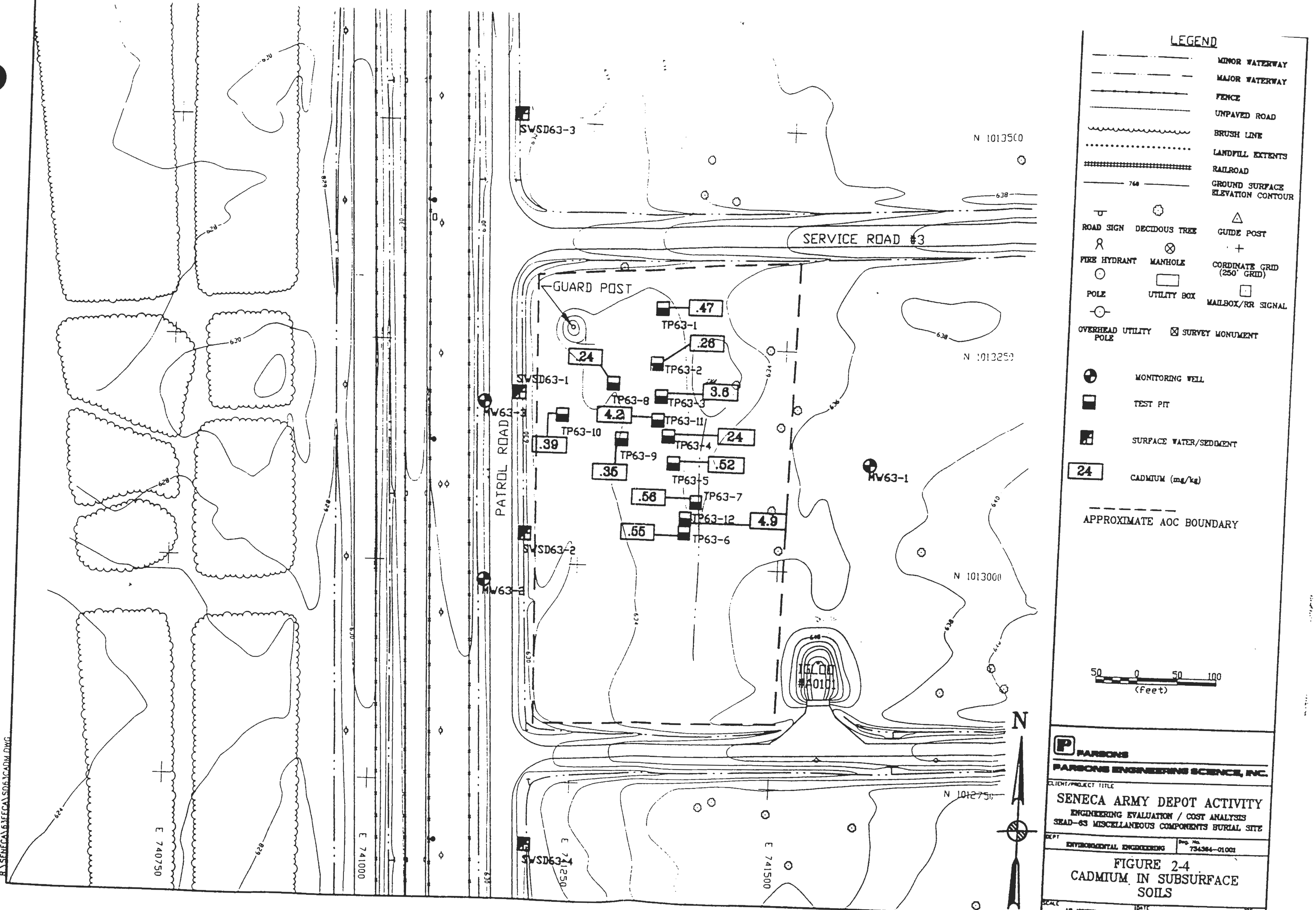
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT. ENVIRONMENTAL ENGINEERING
Dwg. No. 734384-01001

FIGURE 2-3
SEAD-63
SITE PLAN

SCALE AS NOTED
DATE SEPTEMBER 1999
REV A



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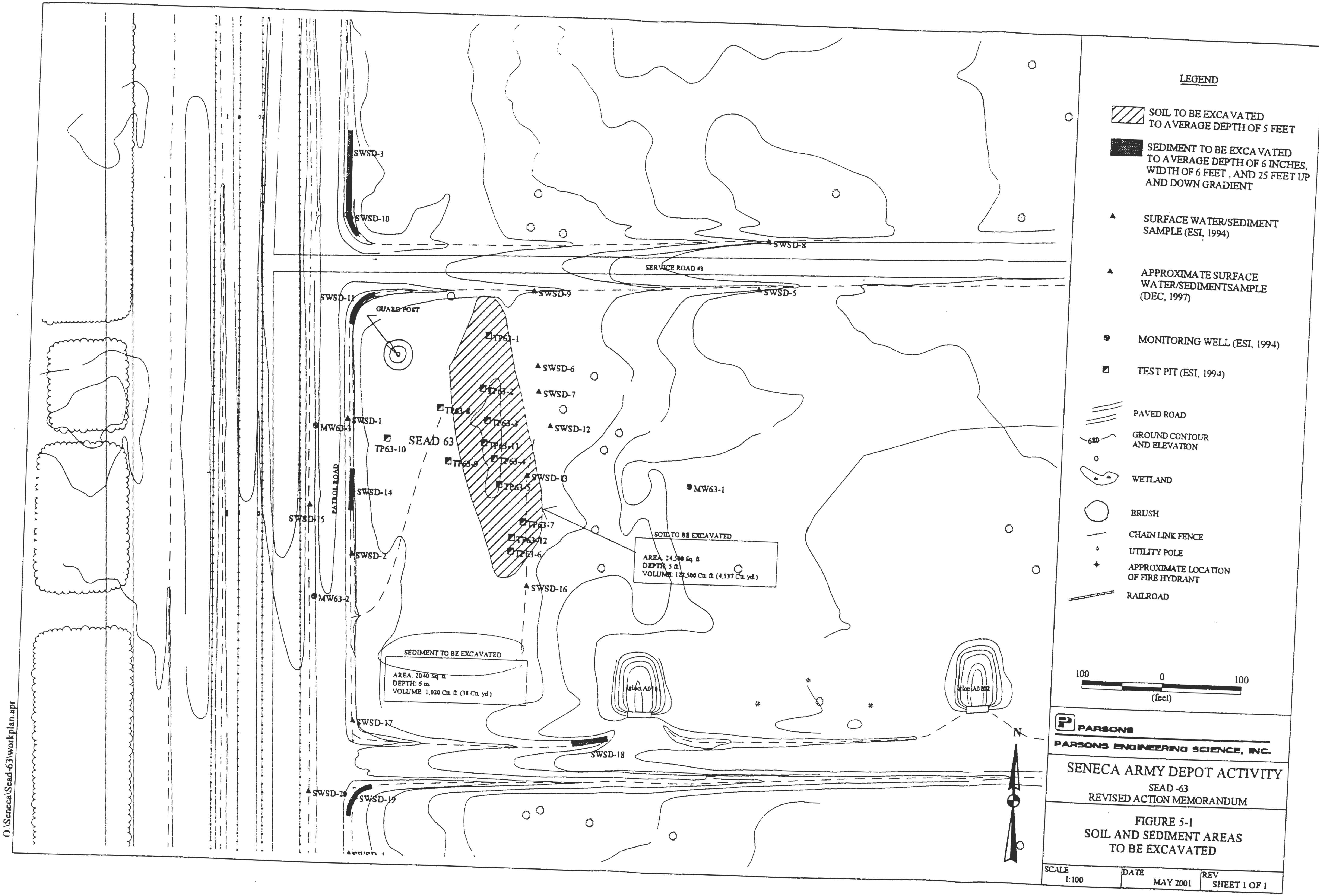
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT	Dwg. No.
ENVIRONMENTAL ENGINEERING	734364-01001

FIGURE 2-4
CADMIUM IN SUBSURFACE SOILS

SCALE	DATE	REV
AS NOTED	SEPTEMBER 1998	A



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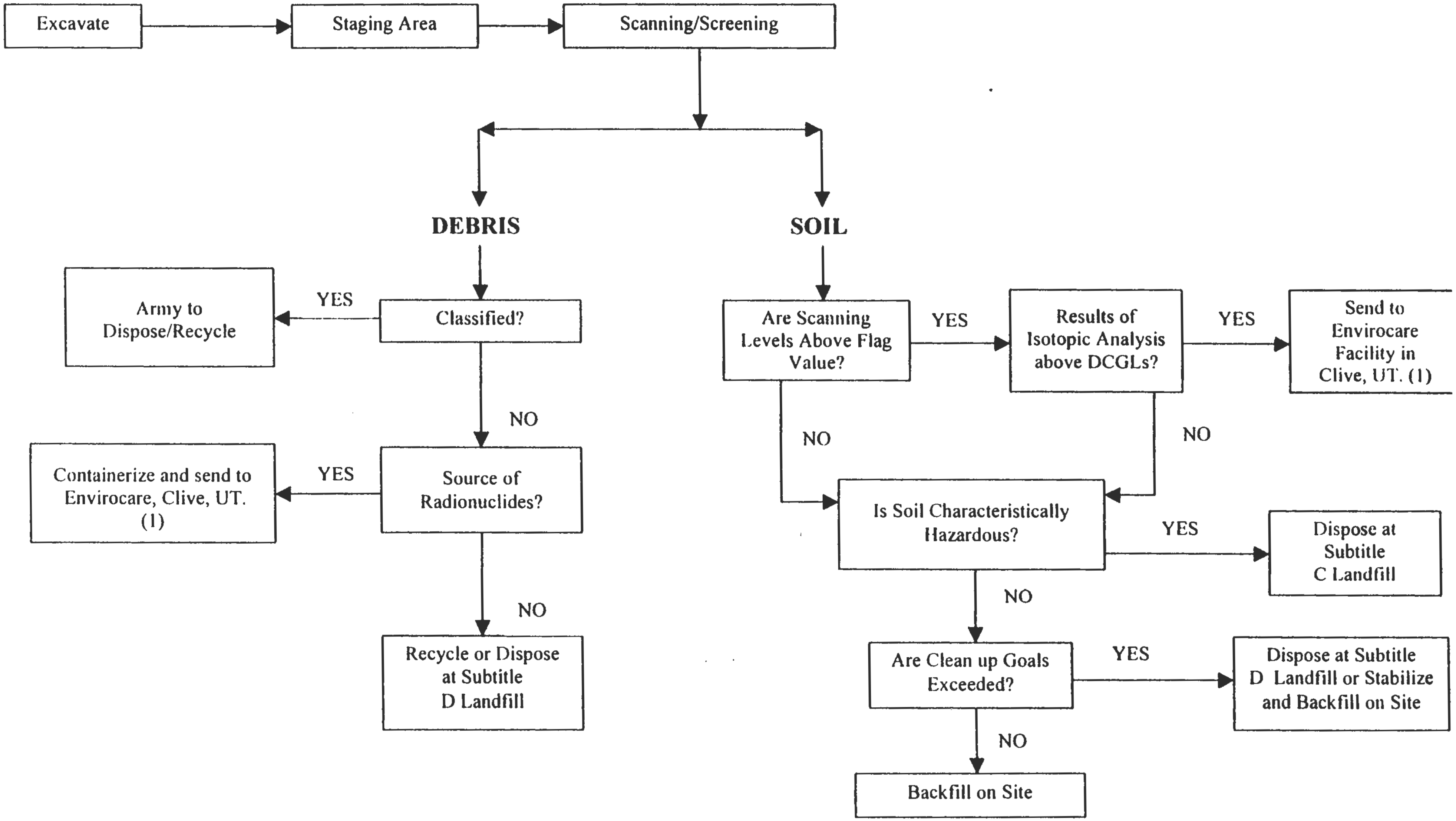
SENECA ARMY DEPOT ACTIVITY
SEAD -63
REVISED ACTION MEMORANDUM

FIGURE 5-1
SOIL AND SEDIMENT AREAS
TO BE EXCAVATED

SCALE	DATE	REV
1:100	MAY 2001	SHEET 1 OF 1

FIGURE 5-2
DISPOSAL DECISION FLOW CHART
SEAD-63 DECISION EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, N.Y.



NOTE: (1) Accepts low level Radioactive Waste

Table 5-1
Preliminary Clean Up Goals for Soil
SEAD-63 Action Memorandum
Seneca Army Depot Activity, Romulus, NY

Clean up Goals for Chemicals of Concern

Cadmium	50 mg/kg (1b)

Clean up Goals for Radionuclides

	Background	Preliminary DCGL - pCi/g (3)			
Isotope	Screening Level (2)	Park Wkr (4	Rec Child (5)	Const. Wkr (5)	Residential (6)
Ac-227	0.4	10.52	15.86	3.412	1.6
Cs-137	0.7	8.473	9.759	6.839	12.2
Co-57	0.1	56.06	64.56	45.31	94.2
Co-60	0.305	1.771	2.04	1.432	3
Lead-210	4.3	151	1156	22.57	2.79
Pm-147					49350
Pu-239/240	0.2	260	2820	34.83	20
Ra-226	2.315	2.55	2.944	2.033	0.12
Ra-228	2.645	4.765	5.517	3.749	2.35
Th-228		2.791	3.225	2.211	3.89
Th-230	1.75	924.6	9481	110.9	0.33
Th-232	1.81	192	2813	22.25	1.3
Tritium	16.51	52930	2148000	52020	80
U-233/234	1.14	2048	21860	24.92	38.5
U-235	0.305	36.68	42.88	27.09	6.7
U-238	1.21	191.3	238.6	104.2	73.6

(1a) Based on TAGM value.; 1b) based on health risk calculation

(2) Background Screening Level set to 95th percentile value. If 95th percentile exceeded the max value (due to high SQLs), the maximum value was used instead.

(3) Derived using RESRAD and a dose equivalent of 10 mrem/yr. Assumed an impacted area (above background) of 3439 m2.

(4) The Preliminary DCGLs derived for SEAD-63 for the Construction Worker scenerio included the following pathways: dermal contact to soil, inhalation of dust in ambiant air, and soil ingestion.

(5) The Preliminary DCGLs derived for SEAD-63 for the Park Worker and the Recreational scenerios included the following pathways: dermal contact to soil, inhalation of dust in ambi soil ingestion, and ingestion of groundwater.

Table 5-2
Military Items That Contain Radionuclides As Integral Parts Of Their Components
SEAD-12 Remedial Investigation Report
Seneca Army Depot Activity

Military Item	Isotope
Front Sight Post Assembly	H-3
Radioluminous Fire Control Devices	H-3
Compasses	H-3
Infinity Collimator	H-3
M1A1 Collimator	H-3
M1A1 Quadrant Fire Control Device	H-3
M58 and M59 Aiming Light Post	H-3
Wrist Watches	H-3
M72 Light Antitank Weapon (LAW)	Pm-147
Front Sight Post Assembly	Pm-147
Radium Dial/Compass/Check Source	Ra-226
MC-1 Moisture Density Tester	Am-241
M8A1 Chemical Agent Alarm	Am-241
MA1 Tank Armor	U-238
M1 Tank Armor	DU (Depleted Uranium)
MC-1 Moisture Density Gauge	Cs-137 Am-241

DRAFT EE/CA
TABLE OF CONTENTS

Table 5-3
Discharge Criteria for Water
SEAD-63 Action Memorandum
Seneca Army Depot Activity, Romulus, NY

Radionuclides Detected in SEAD-63 Soils	Criteria for Effluent Released to Unrestricted Areas (1,2)		Release to Sewers (3,4)	
	uCi/mL	pCi/L	uCi/mL	pCi/L
Cs-137	1.00E-06	1000	1.00E-05	10,000
Pb-210	1.00E-08	10	1.00E-07	100
Ra-226	6.00E-08	60	6.00E-07	600
Ra-228	6.00E-08	60	6.00E-07	600
Th-228	2.00E-07	200	2.00E-06	2,000
U-235	3.00E-07	300	3.00E-06	3,000
U-238	3.00E-07	300	3.00E-06	3,000

(1) Table II "Effluent Concentrations", 6 NYCRR Part 380-11.7.

(2) The concentration values given in Table II are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equival of 50 mREM to "reference man" (6 NYCRR Part 380-11.4).

(3) Table III "Releases to Sewers", 6 NYCRR Part 380-11.7.

(4) The concentration values given in Table III are such that, if the sewage released by the licensee we only source of water indested by a reference man during a year, woul result in a committed effective do equivalent of 500 mREM.

Substance[1]		Category[2]	Maximum Allowable Concentration (ug/L)
Aluminum		A	2000
Arsenic		A	50
Cadmium		A	10
Copper		A	1000
Iron*		A	600/1000
Lead		A	50
Manganese*		A	600/1000
Bis(2-ethylhexyl) phthalate		A	5
Phenol		A	2

1) Substance from Table 5 of TOGS 1.1.1 - Effluent Limitations (Class GA)

2) Catagory A effluent limitations from regulation (6 NYCRR 703.6)

* For Iron and Manganese limitation of 600 ug/L for each or 1000 ug/L combined.

FIGURES

Title **Page**

TABLES

APPENDICES

ABBREVIATIONS AND ACRONYMS

See Action Memorandum

1.0 INTRODUCTION

1.1 PURPOSE, SCOPE, AND OBJECTIVES

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared for SEAD-63 at the Seneca Army Depot (SEDA) by Parsons Engineering Science (Parsons ES) in support of the proposed non-time-critical removal action at SEAD-63. Parsons ES has been retained by the United States Army Corps of Engineers (USACE) Huntsville Division as part of their remedial response activities under the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA) to perform these activities.

This report is based on the finding of the Expanded Site Inspection (ESI) conducted at SEAD-63 (Parsons ES, 1995) and Remedial Investigation (RI) activities conducted in Fall 1997. Activities conducted as part of the ESI included: (i) seismic, electromagnetic (EM) and ground penetrating radar (GPR) surveys, as well as test pits, to determine groundwater flow direction and the exact location of the miscellaneous burial pits, (ii) soil borings to gather stratigraphic information, (iii) soil samples from borings and test pits for analytical testing, (iv) construction and sampling of overburden groundwater monitoring wells, and (v) collection of surface water and sediment samples for analysis. Based on the results of the ESI, a Remedial Investigation/Feasibility Study (RI/FS) was recommended in the ESI report. The field activities scoped for the RI/FS investigation are described in the SEAD-12 and SEAD-63 Project Scoping Plan for Performing a CERCLA RI/FS At Building 804 and the Associated Radioactive Burial Sites (SEAD-12) and the Miscellaneous Components Burial Site (SEAD-63) (Parsons ES, June 1998). Only a portion of the field activities scoped in this plan was conducted. The activities conducted included: (i) additional EM and GPR surveys, (ii) gamma scanning survey, and (iii) sediment and surface water sampling. After this portion of the RI field work was conducted the Army decided to conduct an EE/CA at SEAD-63 rather than continue the RI activities that had been originally proposed in the scoping plan. The Army's intent to conduct an EE/CA at SEAD-63 is documented in the EE/CA Approval Memorandum for SEAD-63 (Parsons ES, October 1998).

The purpose of this removal action is to mitigate the source of heavy metals and possibly radioactivity through the removal of debris at SEAD-63 thereby reducing the chance of further degradation of soils and groundwater.

The EE/CA is an evaluation of the removal action alternatives for a site. While similar to an RI/FS, it is less comprehensive. **Table 1-1** compares the RI/FS and EE/CA process. The purpose of the EE/CA is to present the following:

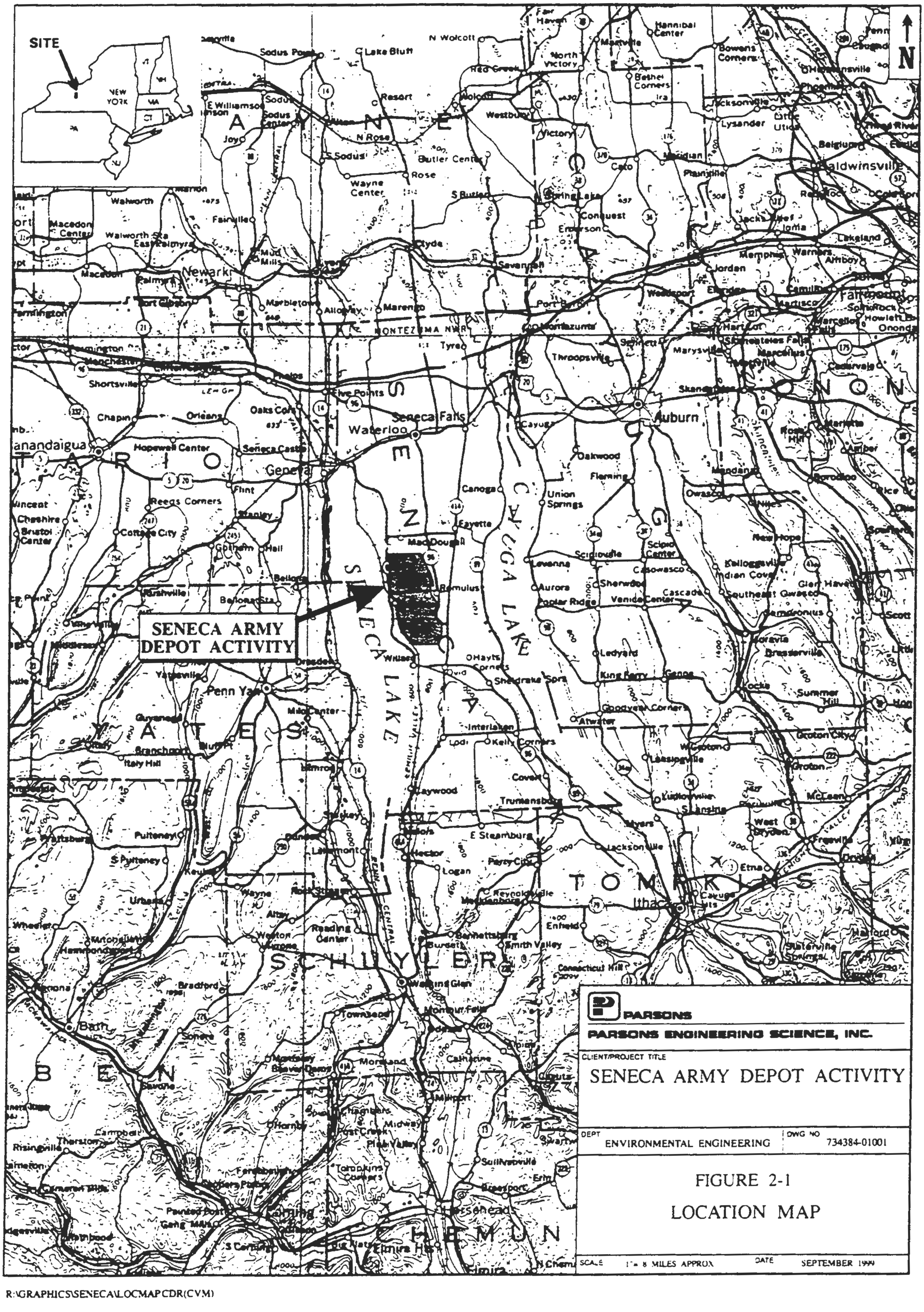
- Assess the study area characteristics and justify the need for a removal action
- Identify removal action objectives
- Identify removal action technologies
- Evaluate removal action technologies
- Propose a removal action that will achieve the removal action objectives.

Additionally, the EE/CA serves as a basis for the action memorandum and the design of the removal action. The action memorandum documents the need for a removal action and the decision process leading to a removal action.

The overall objective of a removal action is to eliminate or reduce the threats to human health or to the environment. The primary threat from the soil and debris at this site is the potential for uncontrolled releases of hazardous constituents from the subsoils to the groundwater. The removal debris and possibly soils from the site is necessary for the protection of human health and the environment.

1.2 STATUTORY AUTHORITY

Authority for responding to releases or threats of releases from a hazardous waste site is addressed in section 104 of CERCLA, as amended. The Army has been delegated the response authority for Army sites, whether or not the sites are on the National Priorities List of the U.S. Environmental Protection Agency (EPA). Under CERCLA Section 104(b), the Army is authorized to investigate, survey, test, or gather other data required to identify the existence, extent, and nature of contaminants, including the extent of danger to human health or welfare and the environment. In addition, the Army is authorized to undertake planning, engineering, and other studies or investigations appropriate to directing response actions that prevent, limit, or mitigate the risk to human health or welfare and the environment.



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SENECA ARMY DEPOT ACTIVITY

DEPT	DWG NO
ENVIRONMENTAL ENGINEERING	734384-01001

FIGURE 2-1

LOCATION MAP

SCALE 1" = 8 MILES APPROX DATE SEPTEMBER 1999

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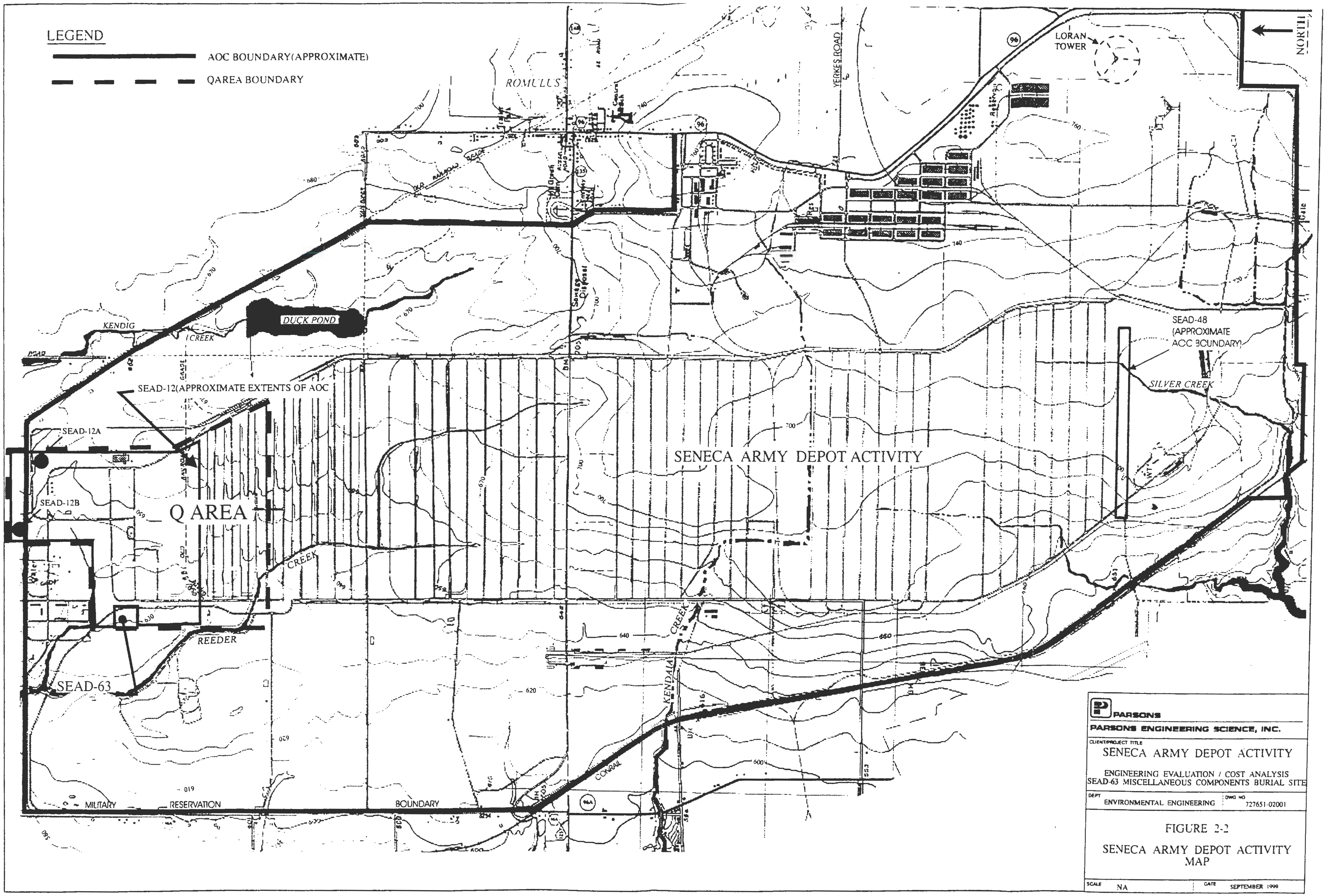

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SENECA ARMY DEPOT ACTIVITY

ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT ENVIRONMENTAL ENGINEERING
DWG NO 727651-02001

FIGURE 2-2

SENECA ARMY DEPOT ACTIVITY MAP

SCALE NA
DATE SEPTEMBER 1999

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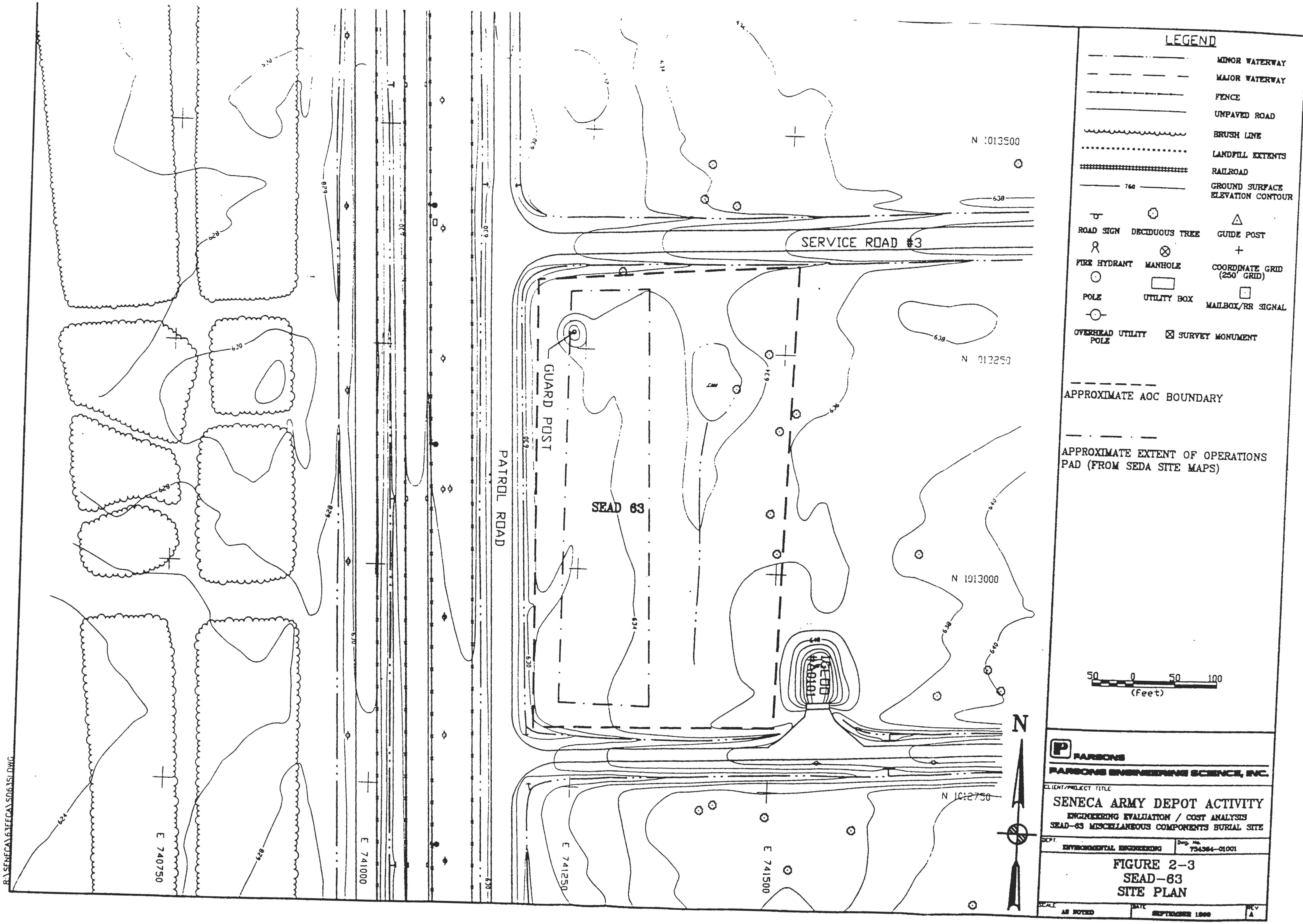

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SENECA ARMY DEPOT ACTIVITY
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT. ENVIRONMENTAL ENGINEERING
Dwg. No. 734364-01001

FIGURE 2-3
SEAD-63
SITE PLAN

SCALE AS NOTED
DATE SEPTEMBER [illegible]
REV A

Topography on-site is generally flat with only a small westward slope. Drainage ditches are adjacent to Patrol Road and the east-west trending roads that bound the site to the north and south. A light ground depression, sloping south to north, is located in the northeastern quadrant of the site. Reeder Creek is located approximately 1500 feet southwest of the site where it flows west into Seneca Lake. The site was used during the 1950s and 1960s as a disposal area for classified parts. Multiple disposal pits were excavated along a north-south line approximately 200 feet long. The individual pits were between 10 and 30 feet long and were likely to have been excavated down to the surface of the weathered shale. SEDA personnel have identified the types of materials disposed at this site as metal parts. The SWMU Classification Report states that "inert materials" were buried within the disposal pits.

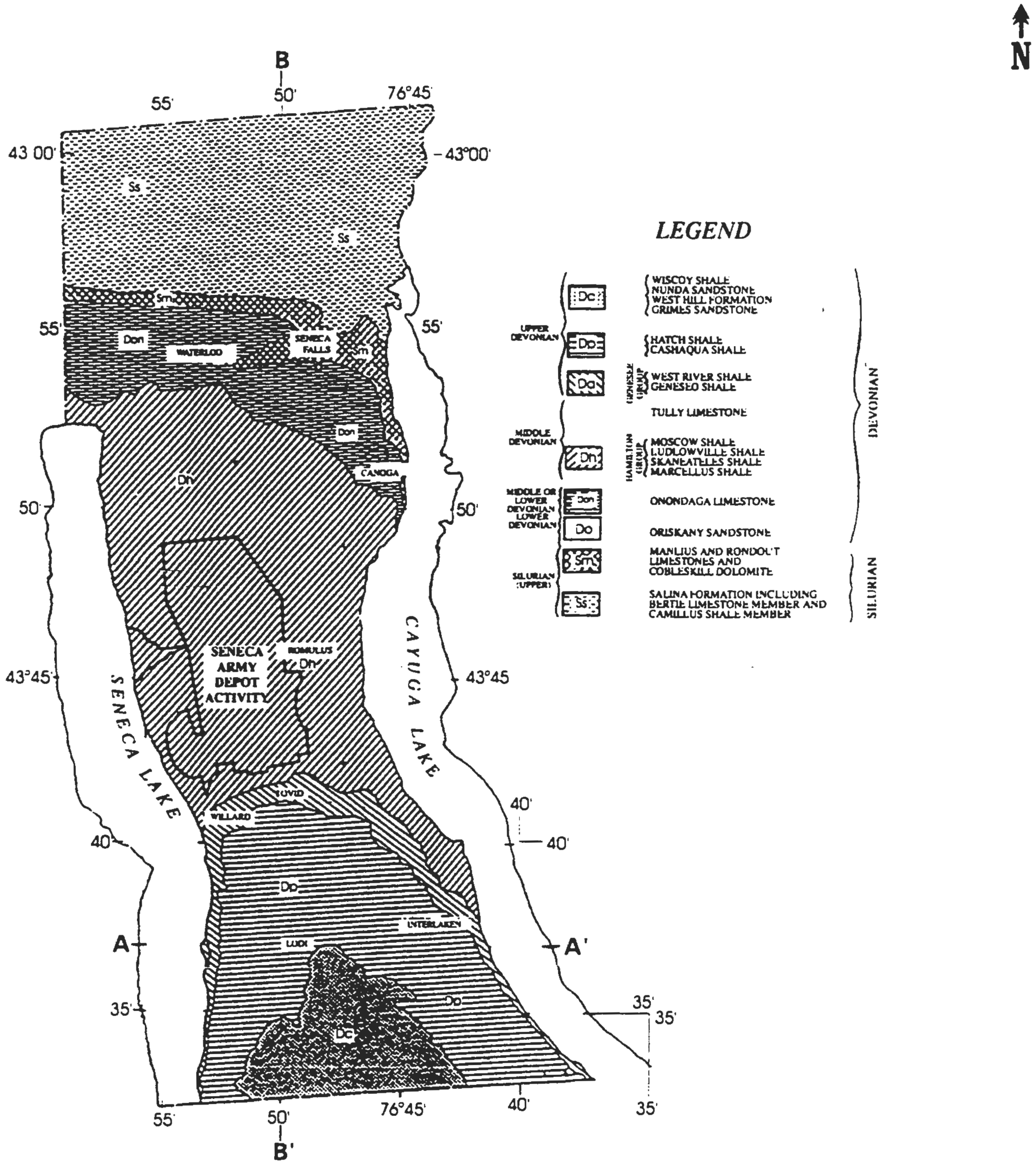
The Expanded Site Inspection (ESI) field work conducted in 1994 (Parsons ES, 1995), provided further information on the nature and extent of contamination. Based on the conclusions of the ESI, a Remedial Investigation/Feasibility Study (RI/FS) was recommended and a portion of the field activities associated with the RI was performed. The results of the ESI and RI field work conducted are discussed below.

2.2 REGIONAL GEOLOGICAL AND HYDROGEOLOGICAL SETTING

2.2.1 Regional Geology

The Finger Lakes uplands area is underlain by a broad north-to-south trending series of rock terraces mantled by glacial till. As part of the Appalachian Plateau, the region is underlain by a tectonically undisturbed sequence of Paleozoic rocks consisting of shale, sandstone, conglomerate, limestone, and dolostone. **Figure 2-4** shows the regional geology of Seneca County. In the vicinity of SEDA, Devonian age (385 million years bp) black shale of the Hamilton group is monoclinally folded and dips gently to the south. No evidence of faulting or folding of the sediments is present.

Pleistocene age glacial till deposits overlie the shale. The till matrix, the result of glaciation, varies locally but generally consists of horizons of unsorted silt, clay, sand, and gravel. In the Finger Lakes region of New York, the till thickness varies from 1 to 50 meters. However, on the till plain between Seneca and Cayuga Lake it is near the surface and generally thin (Muller and Cadwell, 1986). In the central and eastern portions of SEDA the till is thin and bedrock is exposed or within 1



SOURCE: MODIFIED FROM THE GROUND WATER RESOURCES OF SENECA COUNTY, NEW YORK: MOZOLA, A.J., BULLETIN GW-26. ALBANY, NY. 1951

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SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT	DWG NO
ENVIRONMENTAL ENGINEERING	734364-01001

FIGURE 2-4

GEOLOGIC MAP OF SENECA COUNTY

SCALE	DATE
1" = 5 MILES	SEPTEMBER 1999

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meter of the surface in some locations. The soils at the site are classified as unsorted inorganic clays, inorganic silts, and silty sands. In general, the topographic relief associated with these soils is 3 to 8%.

2.2.2 Regional Hydrogeology

Regionally, four distinct hydrologic units have been identified within Seneca County. These include two distinct shale formations, a series of limestone units, and unconsolidated beds of Pleistocene glacial till. Overall, the groundwater in the county is very hard, and therefore, the quality is minimally acceptable for use as potable water. Approximately 95 percent of the wells are used for domestic or farm supply and the average daily withdrawal is approximately 500 gallons. About 5 percent of the wells in the county are used for commercial, industrial, or municipal purposes. Seneca Falls and Waterloo, the two largest communities in the county, are in the hydrogeologic region that is most favorable for the development of a groundwater supply. Because the hardness of the groundwater is objectionable to the industrial and commercial establishments operating within the villages, both villages utilize surface water as their municipal supplies. The villages of Ovid and Interlaken, both of which are without substantial industrial establishments, utilize groundwater as their public water supplies. Ovid obtains its supply from two shallow gravel-packed wells, and Interlaken is served by a developed seepage-spring area.

Regionally, the till aquifer would be expected to flow in a direction consistent with the ground surface elevations. Geologic cross-sections from Seneca Lake and Cayuga Lake have been constructed by the State of New York, (Mazola, A.J., 1951 and Crain, L.J., 1974). This information suggests that a groundwater divide exists approximately halfway between the two finger lakes. SEDA is located on the western slope of this divide and, therefore, regional surficial groundwater is expected to flow westward toward Seneca Lake.

Most of the groundwater in Seneca County is derived from precipitation that falls on the land surface and percolates into surficial deposits (Mazola, 1951). Three geologic strata have been used to produce water for both domestic and agricultural purposes. These include the following: 1) a bedrock aquifer, which in this area is predominantly shale; 2) an overburden aquifer, which includes Pleistocene deposits (glacial till); and 3) a deep aquifer present within beds of limestone present within the underlying shale.

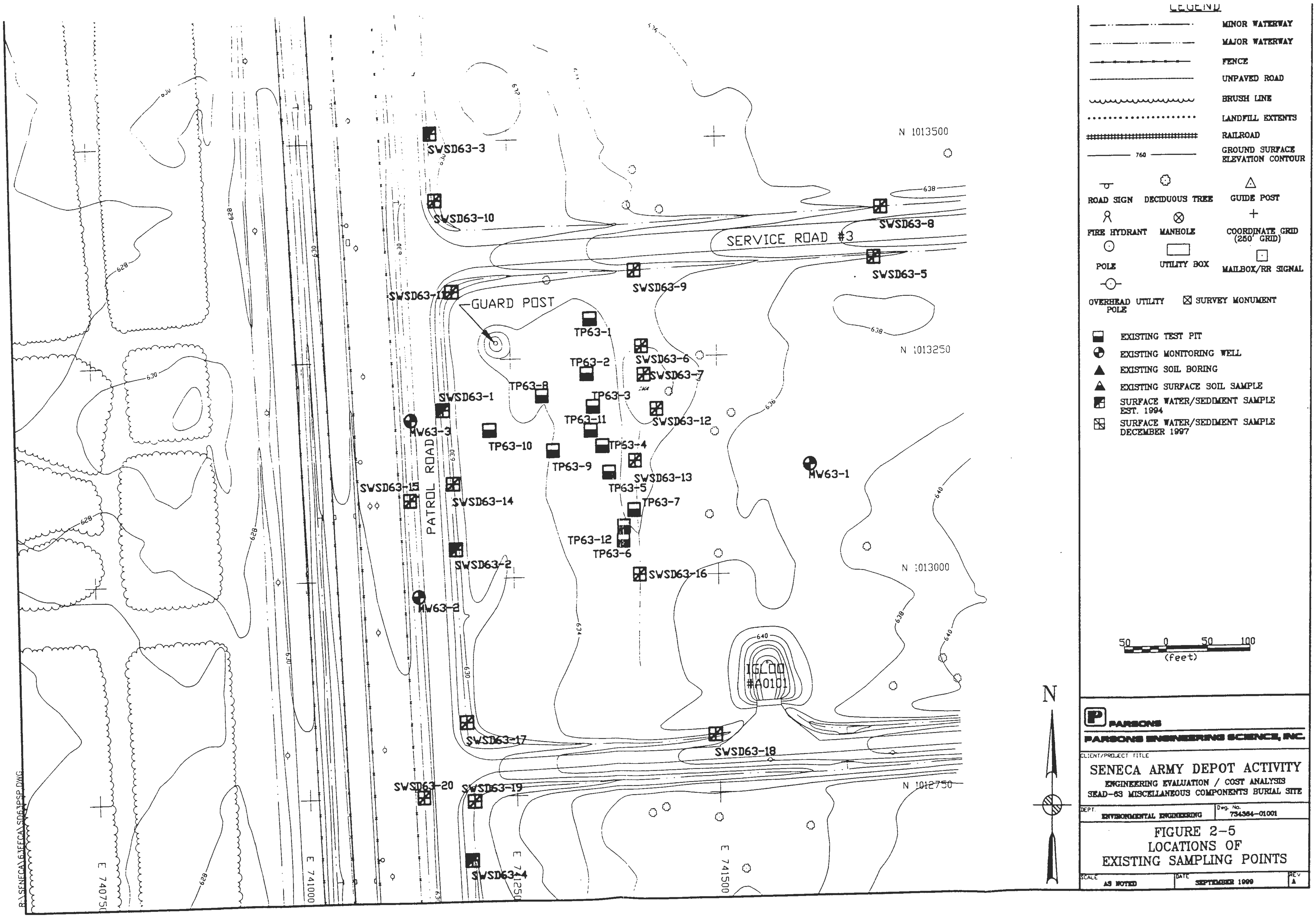
The geologic information reviewed indicates that the upper portions of the shale formation would be expected to yield small supplies of water that would be adequate for domestic use. For mid-Devonian shale such as the Hamilton group, the average yields (i.e., less than 15 gpm), are consistent with what would be expected for shale (LaSala, 1968). The deeper portions of the shale formation, have provided yields up to 150 gpm due to the occurrence of limestone cavities. Very few wells in the region adjacent to SEDA utilize the limestone as a source of water, which may be due to the drilling depths required to intercept this water. Drilling depths of 600 to 700 feet are required to obtain water from the limestone.

2.3 SITE-SPECIFIC GEOLOGY

Determination of the site geology was based on the drilling and test pit programs conducted for the ESI at SEAD-63. This program included 3 soil borings in which monitoring wells were installed and 12 test pits. The soil borings were drilled to a maximum depth of 8.3 feet below ground surface. The locations of monitoring wells and test pits are shown in **Figure 2-5**. Soil boring logs and test pit logs are included in **Appendix B**.

Based on the results of the drilling and test pitting programs, fill material, till, weathered gray shale, and competent gray shale were the four major geologic units identified on-site. A thin topsoil layer (0.1 to 0.9 feet) was present at all three soil boring locations and 10 of the 12 test pit locations. The depths to the bottom of the fill, till, bedrock, and the thickness of the weathered shale at SEAD-63 are presented in the table below.

Boring Location	Depth to Bottom of Fill (feet)	Depth to Bottom of Till (feet)	Thickness of Weathered Shale (feet)	Depth to Bedrock (feet)
MW63-1	NA	5	3	8
MW63-2	NA	6.9	1.3	8.2
MW63-3	NA	6.7	1.6	8.3
TP63-1	>8	ND	ND	ND
TP63-2	1.1	ND	ND	ND
TP63-3	6.5	ND	ND	ND
TP63-4	5.0	ND	ND	ND
TP63-5	NA	ND	ND	ND
TP63-6	3	ND	ND	ND
TP63-7	2.6	ND	ND	ND
TP63-8	1.0	ND	ND	ND



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CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT. ENVIRONMENTAL ENGINEERING

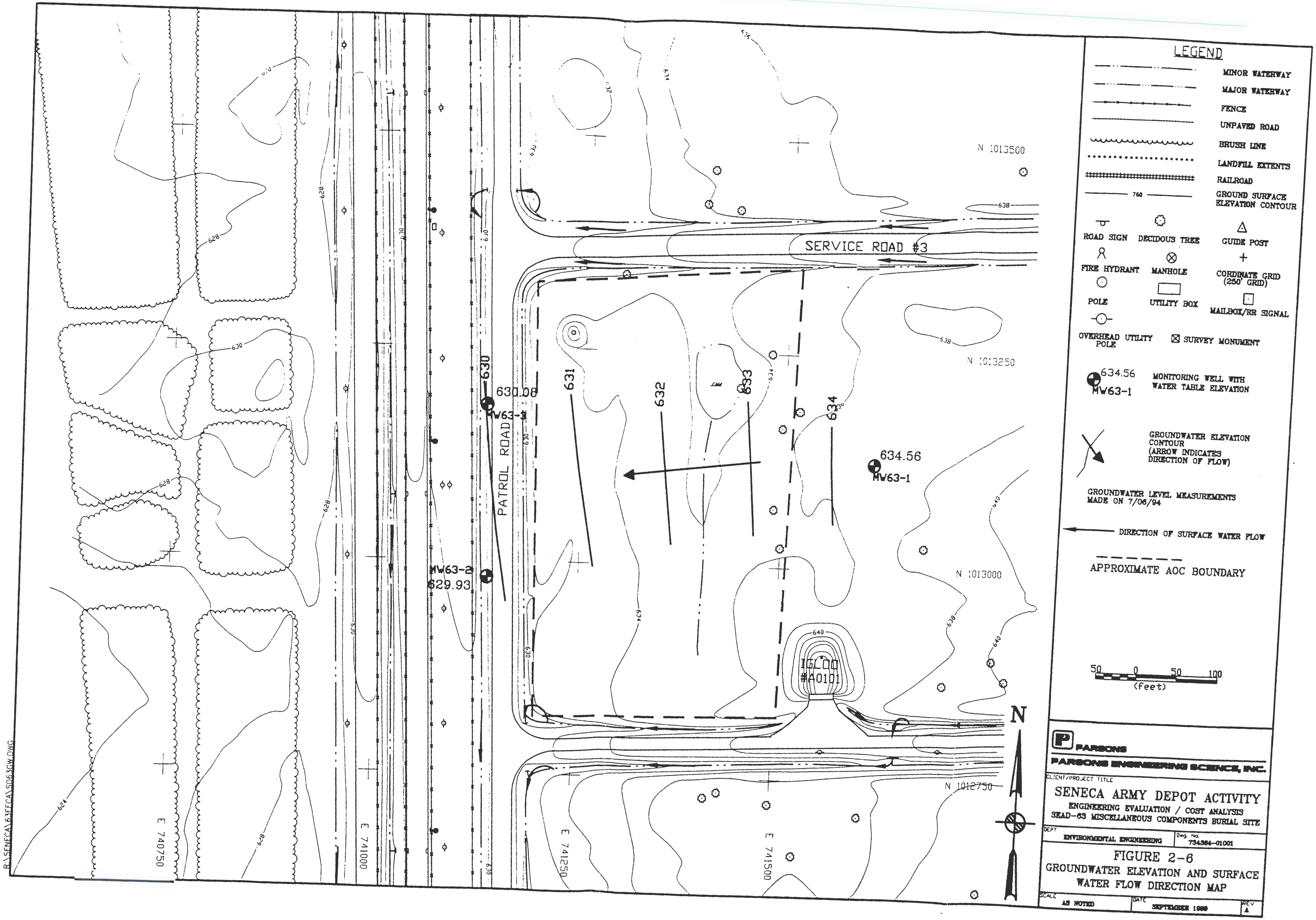
Dwg. No. 734364-01001

FIGURE 2-5
LOCATIONS OF
EXISTING SAMPLING POINTS

SCALE AS NOTED

DATE SEPTEMBER 1999

REV ▲



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ENGINEERING EVALUATION / COST ANALYSIS

SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT	Dwg. No.
ENVIRONMENTAL ENGINEERING	734364-01001

FIGURE 2-6

GROUNDWATER ELEVATION AND SURFACE WATER FLOW DIRECTION MAP

SCALE	DATE	REV
AS NOTED	SEPTEMBER 1999	▲

Boring Location	Depth to Bottom of Fill (feet)	Depth to Bottom of Till (feet)	Thickness of Weathered Shale (feet)	Depth to Bedrock (feet)
TP63-9	2.6	ND	ND	ND
TP63-10	1.0	ND	ND	ND
TP63-11	3.8	ND	ND	ND
TP63-12	0.6	ND	ND	ND

NA = Not Applicable
ND = Not Determined

The fill material was encountered in test pits TP63-1. TP63-3, TP63-4, TP63-7 and TP63-11 and two drums were found in test pit TP63-6. Fill material thickness ranged from 0.6 feet to over 8 feet. The fill consisted of waste material with trace amounts of till, gravel sized shale fragments and sand. The waste material was comprised of miscellaneous military components.

The till was characterized as brown or olive gray silt and very fine sand with small (less than 1 inch) fragments of shale. Clay lenses were observed occasionally. Larger shale fragments, thought to be rip-up clasts, were encountered in some of the soil borings. The till was observed to be 5.0 to 6.9 feet thick in the three soil borings performed at SEAD-63.

The weathered shale that forms the transition between till and competent shale was observed in all three of the soil borings and ranged in thickness from approximately 1.3 to 3 feet.

Competent gray shale was observed in all three soil borings. The depths to bedrock ranged from 8.0 to 8.3 feet below ground surface. In all three soil borings, competent shale was inferred by auger refusal.

2.4 SITE-SPECIFIC HYDROLOGY AND HYDROGEOLOGY

Surface water flow from precipitation events is controlled by local topography and the drainage ditches along the northern, western, and southern boundaries of the site. Surface water flow directions in these drainage pathways are shown in **Figure 2-6**.

As part of the ESI program, three monitoring wells were installed at SEAD-63. Groundwater elevations were measured in all three wells, and are shown on **Figure 2-6.** Based on these data, the groundwater flow direction is primarily to the west and no appreciable changes in the groundwater flow direction were observed over the one month period from June 25, 1994 to July 26, 1994, when groundwater elevations were measured at SEAD-63.

2.5 AREA METEOROLOGY

Table 2-1 summarizes climatological data for the SEDA area. The nearest source of climatological data is the Aurora Research Farm located approximately 10 miles east of the site that provided precipitation and temperature measurements. The remainder of the data reported in **Table 2-1** has been taken from isopleth drawings from the literature, or from data collected at the Syracuse Airport, New York, 40 miles northeast of the SEDA. Meteorological data collected from 1965 to 1974 at Hancock International Airport in Syracuse, New York, were used in preparation of the wind rose. The airport is located approximately 60 miles northeast of SEDA, and is representative of wind patterns at SEDA. The wind rose is presented in **Figure 2-7**.

A cool climate exists at SEDA with temperatures ranging from an average of 23°F in January to 69°F in July. Marked temperature differences are found between daytime highs and nighttime lows during the summer and portions of the transitional seasons. Precipitation is well distributed, averaging approximately 3 inches per month. This precipitation is derived principally from cyclonic storms that pass from the interior of the county through the St. Lawrence Valley. Lakes Seneca, Cayuga and Ontario provide a significant amount of the winter precipitation and moderate the local climate. The annual average snowfall is approximately 100 inches. Wind velocities are moderate, but during the winter months there are numerous days with sufficient winds to cause blowing and drifting snow. The most frequently occurring wind directions are westerly and west-southwesterly.

As **Table 2-1** shows, temperature tends to be highest from June through September. Precipitation and relative humidity tend to be rather high throughout the year. The months with the most amount of sunshine are June through September. Mixing heights tend to be lowest in the summer and during the morning hours. Wind speeds also tend to be lower during the morning, which suggests that dispersion will often be reduced at those times, particularly during the summer. No episode-days are expected to occur with low mixing heights (less than 500 m) and light wind speeds (less than or equal to 2 m/s).

TABLE 2-1

CLIMATOLOGICAL DATA FOR SENECA ARMY DEPOT

SENECA ARMY DEPOT

MONTH	TEMPERATURE[1] (°F) MAX	MIN	MEAN	PRECIP[1] (in) MEAN	RH[3] (%) MEAN	SUN-SHINE[3] (%)	MEAN NUMBER OF DAYS[4] CLEAR	PTLY. CLDY.	CLOUDY
JAN	30.9	14.0	22.5	1.88	70	35	3	7	21
FEB	32.4	14.1	23.3	2.16	70	50	3	6	19
MAR	40.6	23.4	32.0	2.45	70	50	4	7	20
APR	54.9	34.7	44.8	2.86	70	50	6	7	17
MAY	66.1	42.9	54.5	3.17	70	50	6	10	15
JUN	76.1	53.1	64.6	3.70	70	60	8	10	12
JUL	80.7	57.2	69.0	3.46	70	60	8	13	10
AUG	78.8	55.2	67.0	3.18	70	60	8	11	12
SEP	72.1	49.1	60.7	2.95	70	60	7	11	12
OCT	61.2	39.5	50.3	2.80	70	50	7	8	16
NOV	47.1	31.4	39.3	3.15	70	30	2	6	22
DEC	35.1	20.4	27.8	2.57	70	30	2	5	24
ANNUAL	56.3	36.3	46.3	34.33	70	50	64	101	200

PERIOD	MIXING HEIGHT[2] (m)	WIND SPEED[2] (m/s)
Morning (Annual)	650	6
Morning (Winter)	900	8
Morning (Spring)	700	6
Morning (Summer)	500	5
Morning (Autumn)	600	5
Afternoon (Annual)	1400	7
Afternoon (Winter)	900	8
Afternoon (Spring)	1600	8
Afternoon (Summer)	1800	7
Afternoon (Autumn)	1300	7

Mean Annual Pan Evaporation[3] (in) : 35
Mean Annual Lake Evaporation[3] (in) : 28
Number of episodes lasting more than 2 days (No. of episode-days)[2] :
    Mixing Height < 500 m, wind speed < 2 m/s : 0 (0)
    Mixing Height < 1000 m, wind speed < 2 m/s : 0 (0)
Number of episodes lasting more than 5 days (No. of episode-days)[2] :
    Mixing Height < 500 m, wind speed < 4 m/s : 0 (0)

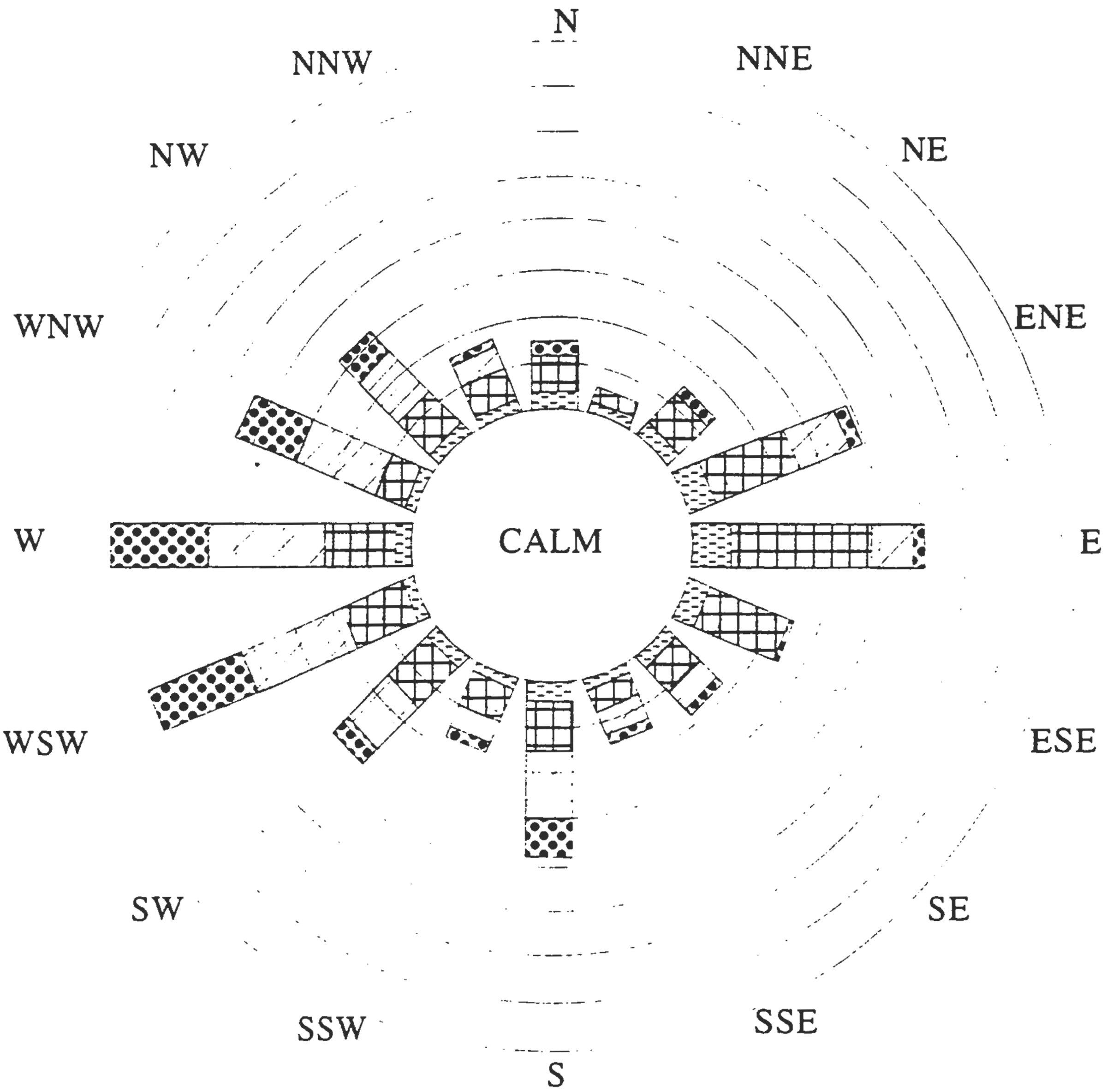
Notes:

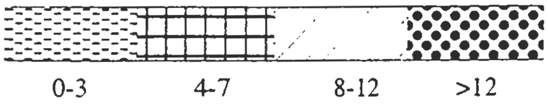
[1] Climate of New York Climatography of the United States No. 60. National Oceanic and Atmospheric Administration, June 1982. Data for Ithaca Cornell University, NY

[2] Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States. George C. Holzworth, Jan. 1972.

[3] Climate Atlas of the United States. U.S. Department of Commerce, 1983

[4] Climate of New York Climatography of the United States No. 60. National Oceanic and Atmospheric Administration, June 1982. Data for Syracuse, NY





NOTE: EACH DIVISION IS 2% OF TOTAL TIME

INSTALLATION: SENECA ARMY DEPOT
LOCATION OF DATA: SYRACUSE, NEW YORK
SOURCE: MODIFIED FROM:
US ARMY ENVIRONMENTAL
HYGIENE AGENCY

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PARSONS ENGINEERING-SCIENCE, INC.

CLIENT/PROJECT TITLE
SENECA ARMY DEPOT ACTIVITY
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT ENVIRONMENTAL ENGINEERING
DWG NO. 734364-01001

FIGURE 2-7

WIND ROSE,
SYRACUSE, NEW YORK

SCALE NA
DATE SEPTEMBER 1999

R:\GRAPHICS\SENECA\WINDROSE.CDR(CVM)

Daily precipitation data measured at the Aurora Research Farm in Aurora, New York (approximately 10 miles east of the site) for the period (1957-1991) were obtained from the Northeast Regional Climate Center at Cornell University. The maximum 24-hour precipitation measured at this station during this period was 3.91 inches on September 26, 1975. Values of 35 inches mean annual pan evaporation and 28 inches for annual lake evaporation are shown in **Table 2-1**. An independent value of 27 inches for mean annual evaporation from open water surfaces was estimated from an isopleth presented in "Water Atlas of the United States" (Water Information Center, 1973).

Information on the frequency of inversion episodes for a number of National Weather Service stations is summarized in "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States" (George C. Holzworth, US EPA, 1972). The closest stations for which inversion information is available are in Albany, New York, and Buffalo, New York. The Buffalo station is nearer to SEDA but almost certainly exhibits influences from Lake Erie. These influences would not be expected to be as noticeable at SEDA.

SEDA is located in the Genesee-Finger Lakes Air Quality Control Region (AQCR). The AQCR is designated as non-attainment for ozone and attainment or unclassified for all other criteria pollutants. Data for the existing air quality in the area surrounding the SEDA cannot be obtained since the nearest state air quality stations are 40 to 50 miles away from the army depot, (Rochester of Monroe County or Syracuse of Onondaga County), and are not representative of the conditions at SEDA. A review of the data for Rochester, which is in the same AQCR as the SEDA, indicates that all monitored pollutants (sulfur dioxide, particulates, carbon monoxide, lead, and ozone) are below state and federal limits, with the exception of ozone. In 1987, the maximum ozone concentration observed in Rochester was 0.127 ppm; however, this value is not representative of the SEDA area, which is a more rural environment.

2.6 CONTAMINATION ASSESSMENT

Geophysical surveys and test pits were performed during the ESI to identify burial sites at SEAD-63. Soil, groundwater, surface water, and sediment were analyzed as part of the ESI conducted at SEAD-63 in 1994. The results of the ESI investigation were presented in the report titled "Expanded Site Inspection, Seven Low Priority AOCs, SEADs 60, 62, 63, 64 (A, B, C, and D), 67, 70 and 71", which was issued in April 1995. A total of 12 subsurface soil samples, 3

groundwater samples, and 4 surface water and sediment samples were collected as part of the ESI at SEAD-63. In addition, 18 surface water and sediment samples were collected in 1997 during the RI activities. The following sections describe the nature and extent of contamination identified at SEAD-63.

2.6.1 Geophysical Survey

2.6.1.1 Seismic Survey

The results of the seismic refraction survey conducted at SEAD-63 are shown in **Table 2-2**. The seismic refraction profiles showed 6 to 9 feet of unconsolidated overburden (estimated at 1,600 ft/sec) overlying bedrock (11,200 to 13, 400 ft/sec). The mid-spread data of profile P3 revealed a compact, 3900 ft/sec, overburden layer. Saturated overburden was not detected by the seismic survey. Due to inherent limitations of the seismic refraction method, a thin layer of saturated overburden (<2 feet) overlying the bedrock surface would be undetectable.

Poor surface conditions prevailed during this seismic survey. Snow melt waters and slush covered much of the site and in many areas was pooled over frozen ground. These conditions resulted in unusually high velocities of the direct arrival waves from the surface layer (typically 2,600 to 4,700 ft/sec). Therefore, the surface velocities were manually reduced to a value of 1,600 ft/sec (the surface wave velocity detected from unfrozen ground on profile P3) during the data interpretation phase. The depths to bedrock calculated from these interpretations were corroborated by the depths to bedrock measured during the monitoring well installations at SEAD-63.

The elevations of the bedrock surface, as determined by these surveys, indicate that the bedrock slopes to the west, generally following the surface topography. Groundwater flow is also expected to move to the west, following the slope of the bedrock.

2.6.1.2 EM-31 Survey

Figure 2-8 shows the apparent ground conductivity measured at SEAD-63 during the ESI. A square shaped conductivity anomaly was detected in the northwest portion of the grid. This anomaly was correlated to the suspected miscellaneous components burial sites. The large conductivity anomaly at the southeastern corner of the grid corresponded to Igloo A0101. A linear anomaly running the length of the western boundary of the grid was presumably associated with underground utilities or

TABLE 2-2
SEAD 63

Expanded Site Inspection
Results of Seismic Refraction Survey

Profile	Distance[1]	Ground Elevation[2]	Water Table		Bedrock	
			Depth	Elev[2].	Depth	Elev[2].
P1	-5 120	98.8 100			6.0 5.1	92.8 94.9
P2	-5 57.5 120	97.1 96.9 96.6			9.9 7.8 6.7	87.2 89.1 89.9
P3	-5 57.5 120	98.3 97.3 98.1			8.3 8.2 6.9	90.0 89.1 91.2
P4	-5 120	101.4 100.2			8.2 7.1	93.2 93.1

1. All distances are in feet along the axis of each seismic profile and were measured from geophone #1 of each profile.

2. All elevations are relative to an arbitrary datum established at geophone #24 of the SEAD-63 seismic profile P1.

an accumulation of road salt in the drainage ditch along Patrol Road. The guard post in the northwestern corner of the grid was also detected. In general, the ground in the western portion of the grid exhibited slightly higher apparent conductivities than the ground in the eastern portion.

The in-phase response of the EM-31 survey is shown in **Figure 2-9**. The anomaly in the north-central area of the grid better defines the boundaries of the suspected burial pits; however, the square feature identified by the apparent conductivity survey was not detected. Anomalies associated with the guard post, the underground utility and Igloo A0101 were also observed.

Additional EM-31 surveying was conducted during the RI field activities and confirmed the findings of the earlier survey.

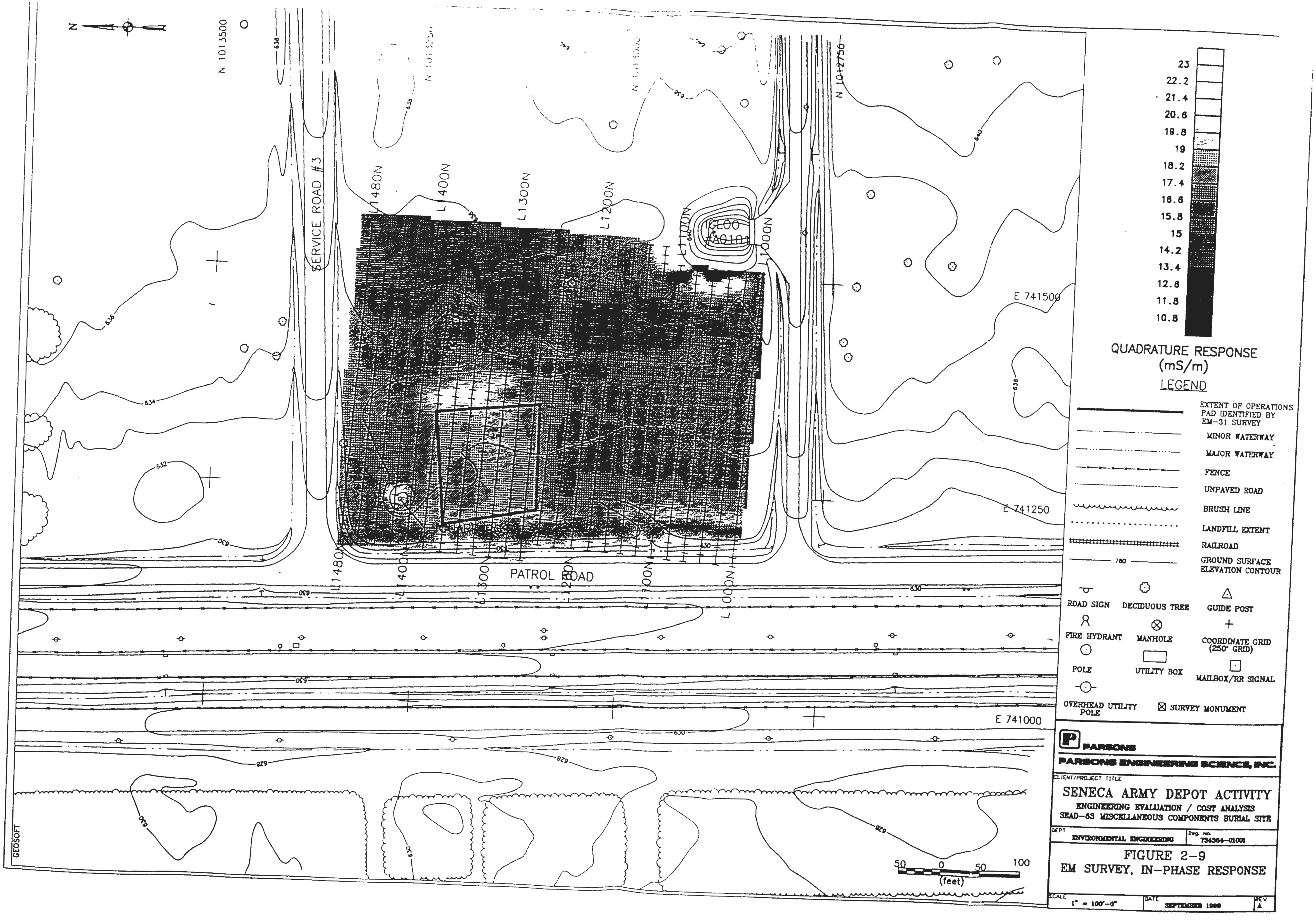
2.6.1.3 GPR Survey

A GPR survey was also conducted at SEAD-63 during the ESI to delineate the extent of the suspected burial pits. A layer of conductive shale gravel, typically 12 inches thick, overlaid the western portion of the survey area, greatly reducing the radar signal penetration through the underlying native soils. In spite of this limitation, the GPR data revealed the presence of several areas where the radar signal reflections from the base of the gravel fill and underlying layers disappeared. **Figure 2-10** shows a typical GPR profile illustrating anomalies of this type. The burial pit boundaries delineated by these anomalies coincided with the boundaries established by the in-phase data from the EM-31 survey.

GPR surveys conducted during the RI confirmed the findings of the ESI survey.

2.6.1.4 Test Pit Results

A total of twelve test pits were excavated in SEAD-63 to characterize the sources of the geophysical anomalies. Nine test pits were excavated in the area of suspected burial pits located by the in-phase response data and the GPR records from SEAD-63 (TP63-1 through TP63-7, TP63-11, and TP63-12). Three test pits were excavated in the square shaped area of increased apparent ground conductivities identified by the EM-31 survey (TP63-8 through TP63-10). The test pit logs are presented in **Appendix B**.



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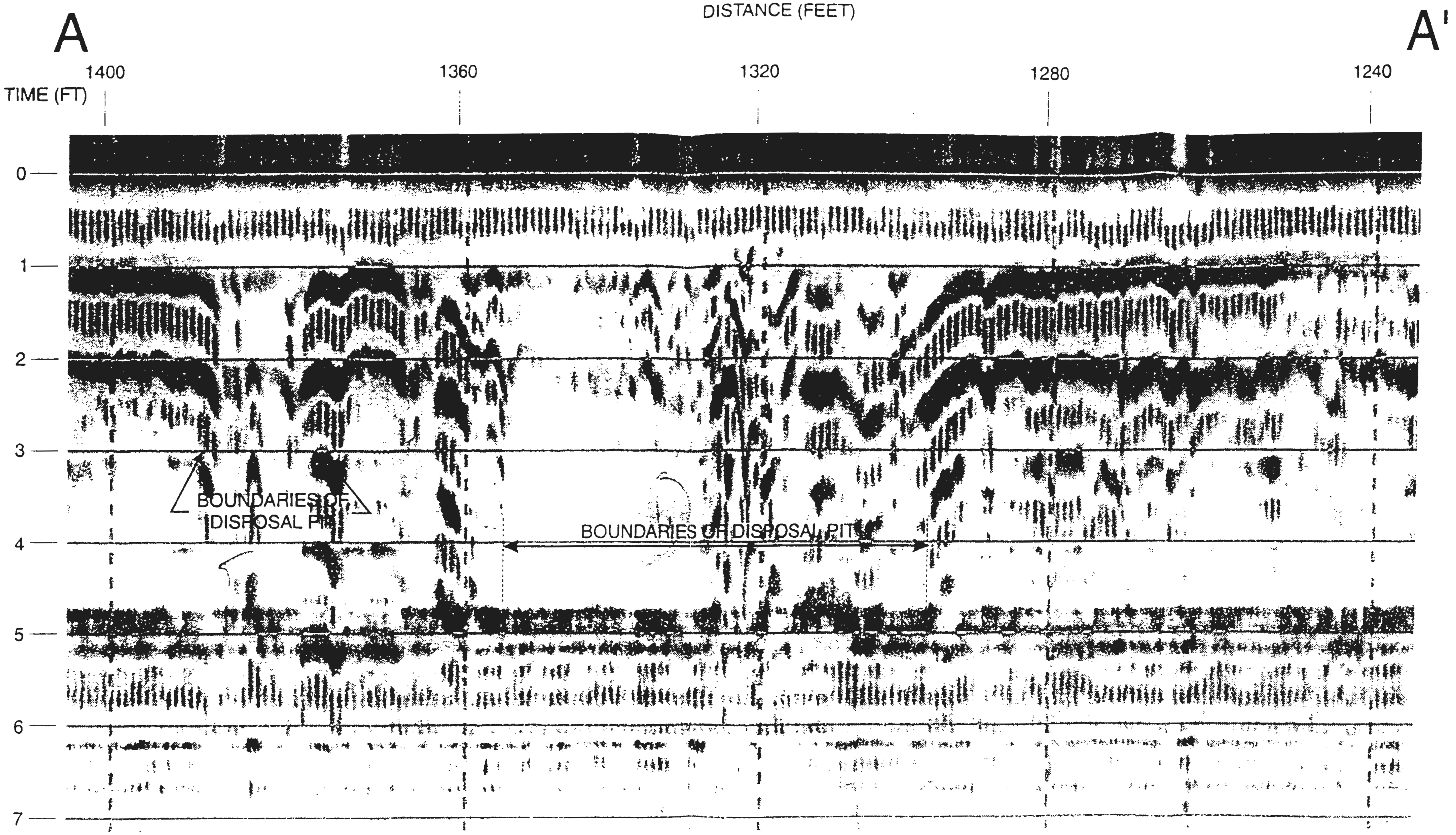
CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT ENVIRONMENTAL ENGINEERING
Dwg. No. 734364-01001

FIGURE 2-9
EM SURVEY, IN-PHASE RESPONSE

SCALE 1" = 100'-0"
DATE SEPTEMBER 1999
REV ▲



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SENECA ARMY DEPOT ACTIVITY

ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT	DWG NO.
ENVIRONMENTAL ENGINEERING	734384-01001

FIGURE 2-10

SEAD-63, GPR PROFILE, A-A'

SCALE	DATE SEPTEMBER 1999

R:\GRAPHICS\SENECA\RADAR\FIG3-3.CDR

TABLE 2-3a
INORGANICS ANALYSIS OF SOIL - SEAD-63
Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity

	Average of Background Soils (ug/kg)	2 x Average of Background Soils (ug/kg)	Average of SEAD-63 Soils (ug/kg)	Is Average of Site data > than 2 x Average of Background data?
Aluminum	13340.53	26681.05	14641.67	No
Antimony	3.56	7.12	0.26	No
Arsenic	5.08	10.15	4.68	No
Barium	78.43	156.86	73.09	No
Beryllium	0.67	1.33	0.66	No
Cadmium	0.97	1.94	2.96	Yes
Calcium	45449.65	90899.30	19976.67	No
Chromium	20.32	40.64	25.31	No
Cobalt	11.39	22.79	12.43	No
Copper	20.99	41.97	33.15	No
Iron	24704.74	49409.47	28291.67	No
Lead	16.47	32.95	22.24	No
Magnesium	10290.18	20580.35	6735.83	No
Manganese	576.14	1152.28	441.00	No
Mercury	0.04	0.09	0.09	Yes
Nickel	30.39	60.79	38.08	No
Potassium	1487.25	2974.49	1640.83	No
Selenium	0.63	1.26	1.17	No
Sodium	99.42	198.85	94.67	No
Thallium	0.43	0.86	0.38	No
Vanadium	21.41	42.82	22.71	No
Zinc	67.80	135.60	83.28	No

Notes:
A "Yes" value indicates that site metal levels are higher than background levels and metal will be retained for risk assessment.
A "No" value indicates that levels are considered to be similar to background levels and metal will not be retained for risk assessment.

Miscellaneous military components were found in test pits TP63-1, TP63-3, TP63-4, TP63-7, and TP63-11. Each of these excavations was characterized by dark gray shale gravel fill overlying the burial pits. The base of the burial pits could not be determined in any of these five excavations due to the presence of a perched water layer within the buried materials. Components found in these test pits included battery assemblies, accelerometers, lock mechanisms, fire/safe pins, baroswitches, wiring, and quick connects. Test pit TP63-6 identified two drums buried in an up-right position with their tops approximately one foot below grade. Both drums were in good condition and very little rust was noted on their surfaces. One of these drums had the words "BURIAL PIT" stenciled on its side. This drum was opened during the test pitting activities and electronics components were observed within it. No liquids were observed in the drum and all radiation and organic vapor field screening measurements that were taken around and within the drum had readings that were equal to background levels. Soil sample TP63-6-1 was collected from the soils at the base of this drum. Test pits TP63-2, TP63-8, TP63-9, TP63-10 and TP63-12 revealed only a layer of shale gravel to a depth of 1 foot, which would explain the source of the elevated ground conductivity observed by the EM-31 survey.

The excavated material was continuously screened for organic vapors with an OVM-580B and for radioactivity with a Victoreen-190 alpha-beta-gamma rate meter, a Ludlum-19 micro-R beta and gamma rate meter and a Ludlum 2221 alpha scintillometer. No readings above background levels (0 ppm for the OVM, 10-15 microrem per hour for the beta and gamma meters, and 6 counts per minute on the alpha meter) were observed during the excavations.

2.6.2 Radiological Survey

A radiological survey was conducted at SEAD-63 as part of the RI field investigation in September 1997. The survey was conducted using a PDR-77 and measured total counts per minute of low energy gamma radiation from the grounds of SEAD-63. As this area was classified as Class II, 50 percent of the grounds was covered by the survey as outlined in the RI/FS Project Scoping Plan for SEAD-12 and SEAD-63. The results of this survey did not indicate that there were any hot spot areas within the grounds of SEAD-63 that required further investigation or an upgrade in classification. All readings were within 50 percent of background levels. Typically, levels between 200 and 300 percent of background may indicate the need for additional surveying and investigation. Survey data are tabulated in **Appendix C**.

2.6.3 Soil

The analytical results for 12 subsurface soil samples collected as part of the ESI investigation for SEAD-63 are presented in **Table 2-3**. These data are compared to the criteria in the Technical and Administrative Guidance Memorandum (TAGM): Determination of Soil Cleanup Objectives and Cleanup Levels (NYSDEC, 1994). The following sections describe the nature and extent of contamination in SEAD-63 soils. The sample locations are shown in **Figure 2-5**.

2.6.3.1 Volatile Organic Compounds

Five volatile organic compounds were detected in two of the 12 soil samples collected. All were found at low concentrations and all were below their respective TAGM values. The volatiles detected were acetone, 2-butanone, benzene, toluene, and xylenes (total). All five volatiles were detected in the sample from TP63-8 and only the latter three were detected in the sample from TP63-9.

2.6.3.2 Semivolatile Organic Compounds

A total of 12 semivolatile organic compounds (SVOCs) were found in the subsurface soil samples analyzed. Only one SVOC compound, dibenz(a,h)anthracene, was detected in a single sample (TP63-9) at an estimated concentration of 28J mg/kg which exceeded its associated TAGM value of 14 mg/kg. All of the remaining concentrations of SVOCs detected in the soil samples from SEAD-63 were below their respective TAGM values.

2.6.3.3 Pesticides/PCBs and Herbicides

Three pesticide compounds were detected in three of the 12 soil samples collected. The pesticides detected were 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT. All three of these pesticides were detected at concentrations below their respective TAGM values.

No PCBs were detected in any of the soil samples.

TABLE 2-3

ESI SOIL ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

COMPOUND	MATRIX LOCATION DEPTH (FEET) SAMPLE DATE ES ID LAB ID SDG NUMBER UNITS	MAXIMUM	FREQUENCY OF DETECTION	TAGM	NUMBER ABOVE TAGM	NUMBER OF DETECTS	NUMBER OF ANALYSES	SOIL SEAD-63 3 06/25/94 TP63-1 225583 45058	SOIL SEAD-63 2 06/26/94 TP63-2 225561 45062	SOIL SEAD-63 6.5 06/26/94 TP63-3 225562 45062	SOIL SEAD-63 3 06/26/94 TP63-4 225563 45062	SOIL SEAD-63 2 06/26/94 TP63-5 225564 45062	SOIL SEAD-63 3 06/27/94 TP63-6 225565 45062
VOCs													
Acetone	ug/Kg	160	8%	200	0	1	12	13 U	12 U	25 U	11 U	12 U	11 U
2-Butanone	ug/Kg	46	8%	300	0	1	12	13 U	12 U	13 U	11 U	12 U	11 U
Benzene	ug/Kg	4	17%	60	0	2	12	13 U	12 U	13 U	11 U	12 U	11 U
Toluene	ug/Kg	23	17%	1500	0	2	12	13 U	12 U	13 U	11 U	12 U	11 U
Xylene (total)	ug/Kg	14	17%	1200	0	2	12	13 U	12 U	13 U	11 U	12 U	11 U
SVOCs													
Phenanthrene	ug/Kg	31	8%	50000	0	1	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Di-n-butylphthalate	ug/Kg	87	8%	8100	0	1	12	87 J	390 U	1800 U	1000 U	410 U	380 U
Fluoranthene	ug/Kg	63	17%	50000	0	2	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Benzo(a)anthracene	ug/Kg	30	8%	224	0	1	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Chrysene	ug/Kg	31	17%	400	0	2	12	420 U	390 U	1800 U	1000 U	410 U	380 U
bis(2-Ethylhexyl)phthalate	ug/Kg	1800	92%	50000	0	11	12	420 U	290 J	230 J	690 J	1800 J	200 J
Benzo(b)fluoranthene	ug/Kg	38	17%	1100	0	2	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Benzo(k)fluoranthene	ug/Kg	43	17%	1100	0	2	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Benzo(a)pyrene	ug/Kg	45	17%	61	0	2	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Indeno(1,2,3-cd)pyrene	ug/Kg	37	8%	3200	0	1	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Dibenz(a,h)anthracene	ug/Kg	28	8%	14	1	1	12	420 U	390 U	1800 U	1000 U	410 U	380 U
Benzo(g,h,i)perylene	ug/Kg	31	8%	50000	0	1	12	420 U	390 U	1800 U	1000 U	410 U	380 U
PEST/PCBS													
4,4'-DDE	ug/Kg	4.4	25%	2100	0	3	12	4.2 UJ	3.9 UJ	4.5 UJ	4.4 J	4.1 UJ	3.8 UJ
4,4'-DDD	ug/Kg	2	8%	2900	0	1	12	4.2 UJ	3.9 UJ	4.5 UJ	2 J	4.1 UJ	3.8 UJ
4,4'-DDT	ug/Kg	3.3	8%	2100	0	1	12	4.2 UJ	3.9 UJ	4.5 UJ	3.3 J	4.1 UJ	3.8 UJ
METALS													
Aluminum	mg/Kg	18000	100%	20650	0	12	12	16800	14800 J	16500 J	12300 J	15300 J	13200 J
Antimony	mg/Kg	0.29	17%	6.27	0	2	12	0.25 UJ	0.26 UJ	0.32 UJ	0.18 UJ	0.27 UJ	0.22 UJ
Arsenic	mg/Kg	6.1	100%	9.6	0	12	12	6.1 J	5.4	4.5	4	4.9	4.5
Barium	mg/Kg	115	100%	300	0	12	12	68.9	65.3 J	115 J	63.2 J	75.4 J	75.9 J
Beryllium	mg/Kg	0.8	100%	1.13	0	12	12	0.71 J	0.74 J	0.8 J	0.53 J	0.69 J	0.84 J
Cadmium	mg/Kg	24	100%	2.46	3	12	12	0.47 J	0.26 J	[illegible]	[illegible]	0.52 J	0.55 J
Calcium	mg/Kg	41500	100%	125300	0	12	12	6810	3830 J	15500 J	28400 J	40500 J	41500 J
Chromium	mg/Kg	43.5	100%	30.95	2	12	12	26.8	22.9 J	[illegible] J	[illegible] J	23.2 J	22.1 J
Cobalt	mg/Kg	14.4	100%	30	0	12	12	14.3	11.8	13.7	13.5	12.4	13.7
Copper	mg/Kg	49.6	100%	32.94	6	12	12	32	27.1 J	[illegible] J	[illegible] J	[illegible] J	[illegible] J
Iron	mg/Kg	34300	100%	38110	0	12	12	34300	30100 J	31200 J	28000 J	28100 J	28000 J
Lead	mg/Kg	38.3	100%	23.49	4	12	12	[illegible]	18.5	[illegible]	[illegible]	22.3	20.7
Magnesium	mg/Kg	9400	100%	21890	0	12	12	6010	4530 J	6790 J	9400 J	8310 J	9180 J
Manganese	mg/Kg	728	100%	1095	0	12	12	464	278 J	728 J	396 J	403 J	438 J
Mercury	mg/Kg	0.49	109%	0.1	1	12	11	0.06 J R	0.05 J	[illegible]	0.03 J	0.06 J	0.03 J
Nickel	mg/Kg	48.4	100%	52.58	0	12	12	41.8	31.5 J	38.7 J	44.2 J	42 J	45.7 J
Potassium	mg/Kg	2160	100%	2623	0	12	12	2160 J	1180 J	1850 J	1250 J	2150 J	1670 J
Selenium	mg/Kg	1.6	100%	2	0	12	12	0.89 J	1.5	1.6	0.91	1.5	0.85
Sodium	mg/Kg	138	83%	187.8	0	10	12	115 J	50.8 J	88.4 J	124 J	138 J	132 J
Thallium	mg/Kg	0.51	42%	0.28	5	5	12	[illegible] J	0.38 U	0.47 U	[illegible] J	[illegible] J	[illegible] J
Vanadium	mg/Kg	28.4	100%	150	0	12	12	28.2	25.2 J	27.2 J	16.8 J	22.4 J	19.3 J
Zinc	mg/Kg	108	100%	115	0	12	12	91.3 J	74.8 J	108 J	100 J	88.9 J	82.4 J
OTHER ANALYSES													
Total Solids	%W/W							79.4	83.7	73.4	92.4	81.2	87.4

TABLE 2-3

ESI SOIL ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

COMPOUND	MATRIX LOCATION DEPTH (FEET) SAMPLE DATE ES ID LAB ID SDG NUMBER UNITS	MAXIMUM	FREQUENCY OF DETECTION	TAGM	NUMBER ABOVE TAGM	NUMBER OF DETECTS	NUMBER OF ANALYSES	SOIL SEAD 63 1 5 06/27/94 TP63 7 225566 45062	SOIL SEAD 63 1 5 06/27/94 TP63 8 225596 45062	SOIL SEAD 63 2 5 06/27/94 TP63 9 225597 45062	SOIL SEAD 63 1 5 06/28/94 TP63 10 225803 45062	SOIL SEAD 63 3 06/28/94 TP63 11 225804 45062	SOIL SEAD 63 5 06/28/94 TP63 12 225805 45062
VOCs													
Acetone	ug/Kg	160	8%	200	0	1	12	12 U	12 U	160	12 U	11 U	12 U
2 Butanone	ug/Kg	46	8%	300	0	1	12	12 U	12 U	46	12 U	11 U	12 U
Benzene	ug/Kg	4	17%	60	0	2	12	12 U	2 J	4 J	12 U	11 U	12 U
Toluene	ug/Kg	23	17%	1500	0	2	12	12 U	6 J	23	12 U	11 U	12 U
Xylene (total)	ug/Kg	14	17%	1200	0	2	12	12 U	14	11 J	12 U	11 U	12 U
SVOCs													
Phenanthrene	ug/Kg	31	8%	50000	0	1	12	380 U	390 U	31 J	410 U	370 U	390 U
Di n butylphthalate	ug/Kg	87	8%	8100	0	1	12	380 U	390 U	400 U	410 U	370 U	390 U
Fluoranthene	ug/Kg	63	17%	50000	0	2	12	380 U	38 J	63 J	410 U	370 U	390 U
Benzo(a)anthracene	ug/Kg	30	8%	224	0	1	12	380 U	390 U	30 J	410 U	370 U	390 U
Chrysene	ug/Kg	31	17%	400	0	2	12	380 U	23 J	31 J	410 U	370 U	390 U
bis(2 Ethylhexyl)phthalate	ug/Kg	1800	92%	50000	0	11	12	80 J	71 J	41 J	67 J	240 J	28 J
Benzo(b)fluoranthene	ug/Kg	38	17%	1100	0	2	12	380 U	21 J	38 J	410 U	370 U	390 U
Benzo(k)fluoranthene	ug/Kg	43	17%	1100	0	2	12	380 U	21 J	43 J	410 U	370 U	390 U
Benzo(a)pyrene	ug/Kg	45	17%	61	0	2	12	380 U	24 J	45 J	410 U	370 U	390 U
Indeno(1 2 3 cd)pyrene	ug/Kg	37	8%	3200	0	1	12	380 U	390 U	37 J	410 U	370 U	390 U
Dibenz(a h)anthracene	ug/Kg	28	8%	14	1	1	12	380 U	390 U	28 J	410 U	370 U	390 U
Benzo(g h i)perylene	ug/Kg	31	8%	50000	0	1	12	380 U	390 U	31 J	410 U	370 U	390 U
PEST/PCBS													
4 4' DDE	ug/Kg	4 4	25%	2100	0	3	12	3 8 UJ	3 9 UJ	4 UJ	4 1 U	1 8 J	2 5 J
4 4' DDD	ug/Kg	2	8%	2900	0	1	12	3 8 UJ	3 9 UJ	4 UJ	4 1 U	3 7 U	3 9 U
4 4' DDT	ug/Kg	3 3	8%	2100	0	1	12	3 8 UJ	3 9 UJ	4 UJ	4 1 U	3 7 U	3 9 U
METALS													
Aluminum	mg/Kg	18000	100%	20650	0	12	12	11700 J	16500 J	13800 J	18000 J	13200 J	13600 J
Antimony	mg/Kg	0 29	17%	6 27	0	2	12	0 23 J	0 3 UJ	0 3 UJ	0 31 UJ	0 23 UJ	0 29 J
Arsenic	mg/Kg	6 1	100%	9 6	0	12	12	4 2	5 2	3 6	5 3	4 3	4 1
Barium	mg/Kg	115	100%	300	0	12	12	45 8 J	59 5 J	87 J	72 4 J	60 J	68 7 J
Beryllium	mg/Kg	0 8	100%	1 13	0	12	12	0 54 J	0 64 J	0 66 J	0 71 J	0 62 J	0 67 J
Cadmium	mg/Kg	24	100%	2 46	3	12	12	0 56 J	0 24 J	0 35 J	0 39 J	[illegible]	0 34 J
Calcium	mg/Kg	41500	100%	125300	0	12	12	39800 J	5440 J	7410 J	14200 J	27500 J	8830 J
Chromium	mg/Kg	43 5	100%	30 95	2	12	12	19 1 J	21 5 J	19 J	24 6 J	25 4 J	23 8 J
Cobalt	mg/Kg	14 4	100%	30	0	12	12	10 7	9 7 J	10 J	12 7	12 4	14 4
Copper	mg/Kg	49 6	100%	32 94	6	12	12	[illegible] J	20 2 J	28 3 J	27 3 J	32 9 J	[illegible] J
Iron	mg/Kg	34300	100%	38110	0	12	12	25000 J	25000 J	22700 J	28500 J	28100 J	30500 J
Lead	mg/Kg	38 3	100%	23 49	4	12	12	15 6	15 5	22 3	17 1	[illegible]	19 5
Magnesium	mg/Kg	9400	100%	21890	0	12	12	8160 J	4400 J	4450 J	5520 J	7970 J	6110 J
Manganese	mg/Kg	728	100%	1095	0	12	12	359 J	350 J	497 J	482 J	458 J	440 J
Mercury	mg/Kg	0 49	109%	0 1	1	12	11	0 04 J	0 08 J	0 07 J	0 05 J	0 04 J	0 05 J
Nickel	mg/Kg	48 4	100%	52 58	0	12	12	39 1 J	23 9 J	26 8 J	33 5 J	41 3 J	48 4 J
Potassium	mg/Kg	2160	100%	2623	0	12	12	1310 J	1530 J	1670 J	2000 J	1460 J	1460 J
Selenium	mg/Kg	1 6	100%	2	0	12	12	0 74	1 3	1 3	1 1 J	1 1	1 1
Sodium	mg/Kg	138	83%	187 8	0	10	12	124 J	50 8 J	45 4 U	46 7 U	84 8 J	39 3 J
Thallium	mg/Kg	0 51	42%	0 28	5	5	12	[illegible] J	0 44 U	0 44 U	0 45 U	0 33 U	0 32 U
Vanadium	mg/Kg	28 4	100%	150	0	12	12	16 8 J	27 6 J	23 1 J	28 4 J	16 7 J	18 8 J
Zinc	mg/Kg	108	100%	115	0	12	12	95 7 J	68 6 J	79 J	63 4 J	76 3 J	70 9 J
OTHER ANALYSES													
Total Solids	%W/W							85 8	85 2	81 9	79 6	90 2	83 7

2.6.3.4 Metals and Cyanide

Several soil samples were found to contain metals at concentrations that exceeded the associated TAGM values. Of the 22 metals reported, 6 were found in one or more soil samples at concentrations above the TAGM values. In earlier reports on SEAD-63 (ESI for Seven Low Priority Sites, April 1995), a greater number of metals exceeded TAGMs. However, since the time of the ESI, more background data have been collected to establish a more representative concentration of metals in background. In addition, the 95th percentile value has been selected as the background concentration rather than the 95th upper confidence level of the mean, which was previously used. The most current background values for metals have been incorporated into this EE/CA. Of the metals that exceeded the TAGM, cadmium and mercury were the only metals that exceeded their TAGM values by more than a factor of 2.

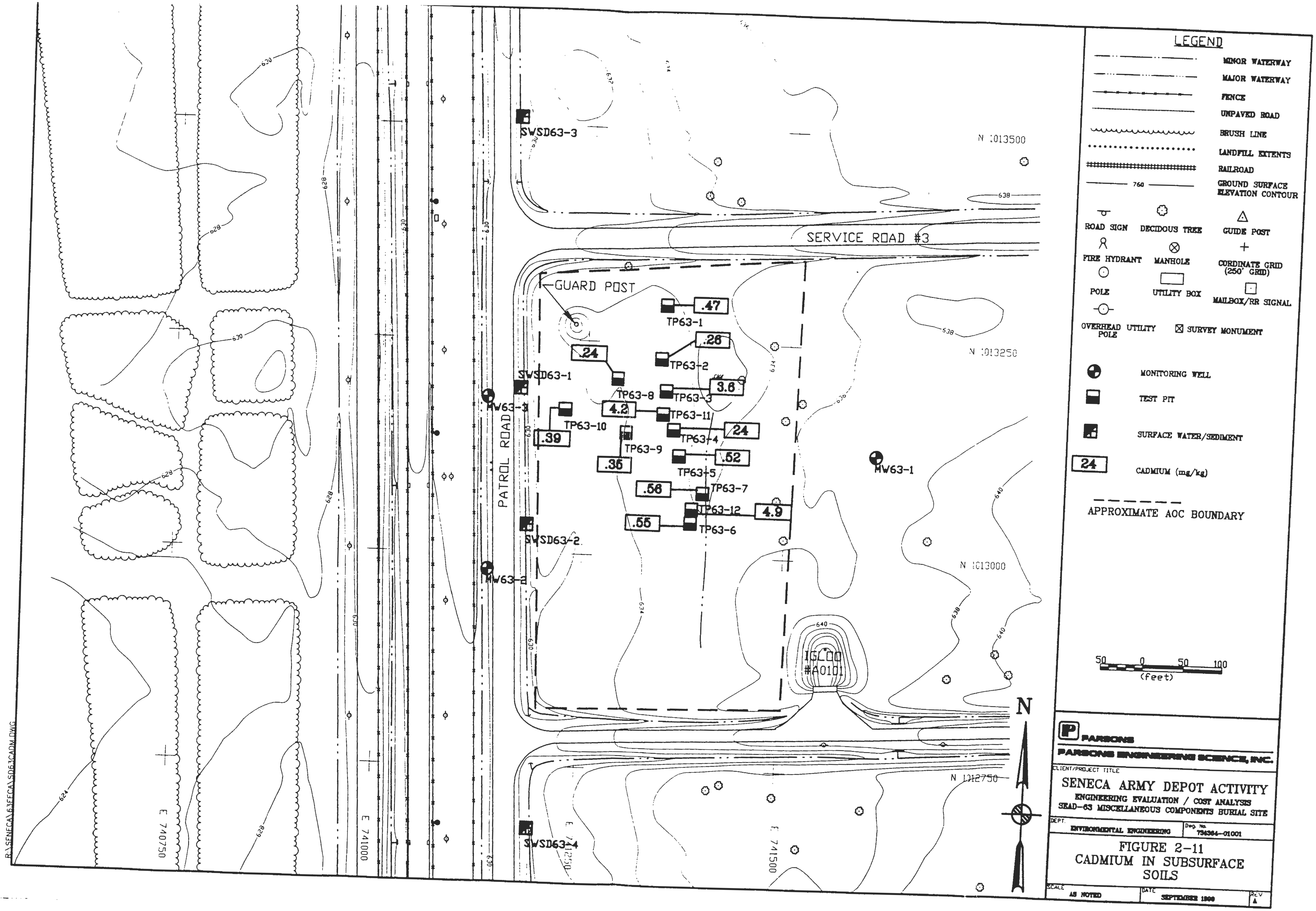
Table 2-3a compares the average concentration of metals detected at SEAD-63 with two times average background concentrations. Cadmium and mercury are the only two metals present in soil that exceed two times the average background concentration of these metals.

The highest concentration of cadmium was detected in sample TP63-4 (24 mg/kg) and was almost 10 times the TAGM value of 2.46 mg/kg. The concentrations of cadmium in subsurface soils are shown in **Figure 2-11**.

The concentration of mercury in sample TP63-3 (0.49 mg/kg) was the only detected concentration of this element that exceeded the TAGM value of 0.1 mg/kg.

2.6.3.5 Radioactivity

The gamma spectral analyses of the soil samples collected during the ESI from SEAD-63 are shown in **Table 2-4**. This table shows the principal radionuclides from the Uranium, Thorium and Actinium decay series. The principal radionuclides Radium-226, Lead-210, and Uranium-235 were detected. The presence of the principal radionuclide Radium-228, Thorium-228, and Uranium-238 was inferred by the detection of one or more of their associated radionuclides. When more than one associated radionuclide was detected, the radionuclide having the highest concentration was assigned to that principal radionuclide. Cs-137 and K-40 were also reported in the gamma spectral analysis. Potassium-40 is a naturally occurring radioisotope. Cs-137 is a



PARSONS

PARSONS ENGINEERING SCIENCE, INC.

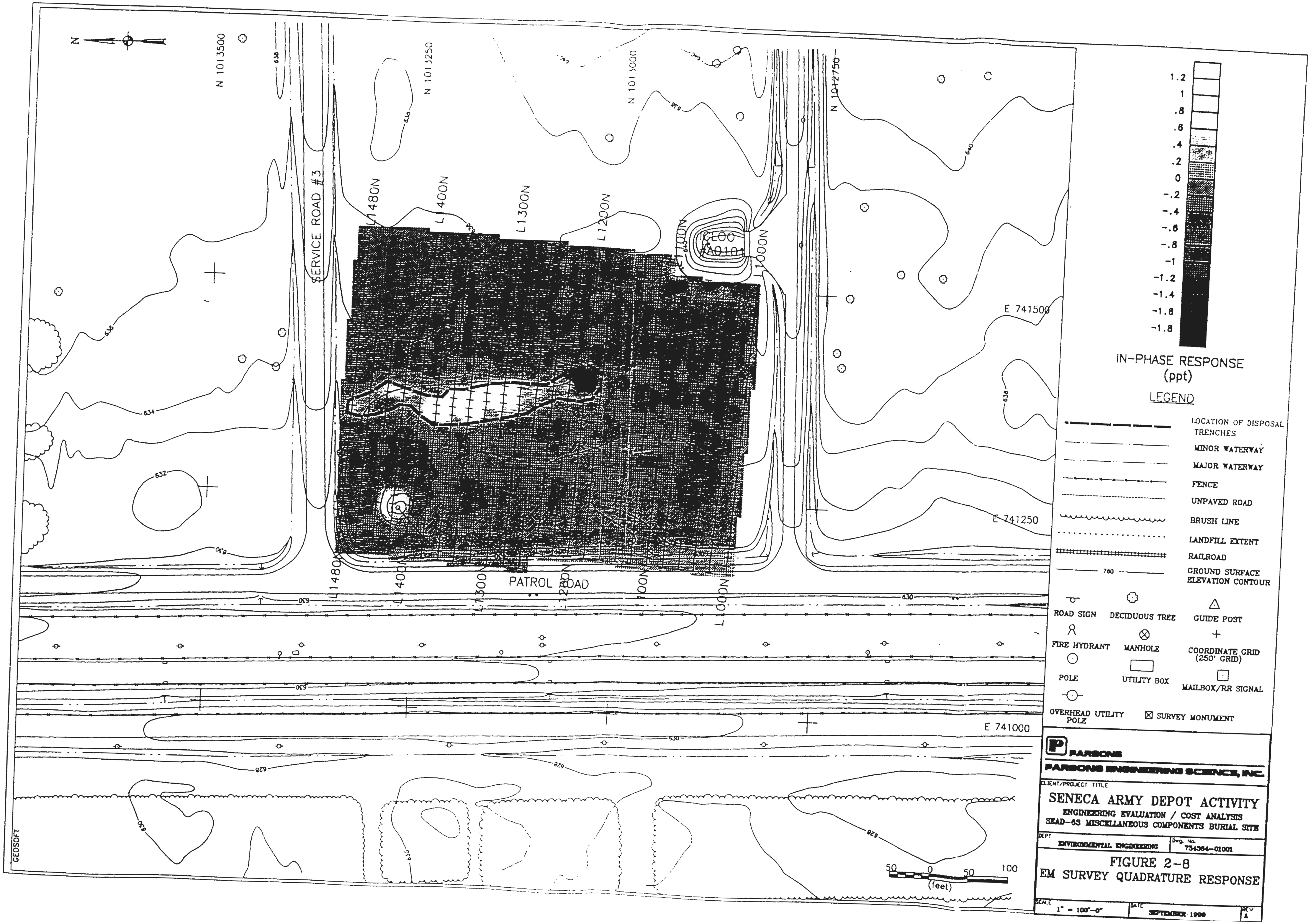
CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	734364-01001

FIGURE 2-11
CADMIUM IN SUBSURFACE SOILS

SCALE	DATE	REV
AS NOTED	SEPTEMBER 1999	A



PARSONS

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SENECA ARMY DEPOT ACTIVITY
ENGINEERING EVALUATION / COST ANALYSIS
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE

DEPT	Dwg. No.
ENVIRONMENTAL ENGINEERING	734364-01001

FIGURE 2-8
EM SURVEY QUADRATURE RESPONSE

SCALE	DATE	REV
1" = 100'-0"	SEPTEMBER 1999	A

T[illegible] 2-4
Soil Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63
	3	2	6.5	3	2	3	1.5	1.5	1.5
	6/25/94	6/26/94	6/26/94	6/26/94	6/26/94	6/27/94	6/27/94	6/27/94	6/27/94
	TP63-1	TP63-2	TP63-3	TP63-4	TP63-5	TP63-6	TP63-7	TP63-57	TP63-8
	225672	225673	225674	225675	225676	225677	225678	225680	225682
								TP63-7DUP	
RADIONUCLIDE ANALYSIS	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
GAMMA SPECTRAL									
Pb-210	2.2	2.2	2	2.2	2.5	2	2.4	1.9	1.9
Ra-226	1.9	1.6	1.4	1.6	1.8	1.7	1.7	1.9	1.9
Ra-228	1.6	1.4	1.6	1.7	1.39	1.8	2.3	1.6	1.6
Th-228	1.6	1.7	1.3	1.4	1.5	1.4	1.7	1.4	1.5
U-235	0.14	0.09	0.3	0.23	0.16	0.15	0.24	0.37	0.48
U-238	0.71	1.24	0.66	1.2	1.5	0.7	1.37	0.88	0.74
GROSS ALPHA	21	20	20	14	15	19	16	20	15
GROSS BETA	43	34	28	42	34	39	38	31	28

Table 2-4
Soil Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	SOIL	SOIL	SOIL	SOIL	SOIL
	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63
	2.5	1.5	3	3	5
	6/27/94	6/28/94	6/28/94	6/28/94	6/28/94
	TP63-9	TP63-10	TP63-11	TP63-511	TP63-12
	225683	225821	225822	225825	225824
				TP63-11DUP	
RADIONUCLIDE ANALYSIS	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
GAMMA SPECTRA					
Pb-210	2.4	2.7	2.6	2.6	2.6
Ra-226	2	1.4	1.9	1.8	1.6
Ra-228	1.33	1.3	1.5	1.7	1.5
Th-228	1.35	1.27	1.9	2	1.6
U-235	0.11	0.13	0.14	0.14	0.2
U-238	1.32	1.36	0.69	1.5	0.73
GROSS ALPHA	18	25	11	15	14
GROSS BETA	29	41	43	46	48

fission product and is present in the environment due to nuclear weapons testing fallout (Eisenbud and Gesell, 1997).

Background soil samples were collected in 1997 during the RI field activities for SEAD-12 and SEAD-63. These samples were analyzed for radioisotopes by gamma spectrometry as well as alpha spectrometry for Th-230/2, U-235/8, and Pu-239/240. Some gamma emitters in the Actinium, Thorium, and Uranium series that were detected during the ESI are weak gamma emitters and are more accurately detected using alpha spectrometry. Alpha spectrometry methods provide lower detection limits for certain radionuclides such as Thorium and Uranium isotopes. While it would be best to compare data derived from the same methods, U-235/238 data from SEAD-63, derived from gamma spectrometry analyses, is compared to background data, derived from alpha spectrometry analyses. Additional radionuclides detected in background using alpha spectrometry or radiochemistry methods other than gamma spectrometry, include Pu-239/240, Tritium, Th-230/232, and Pm-147.

Principal and associated radionuclides were detected in the RI background soil sample analyses. As in the site soils, Ra-226, Pb-210 and U-235 were detected. In addition, principal radionuclides Ac-227, Cs-137, Co-57, Pu-239/240, Ra-228, Th-230, Th-232, U-233/234, and U-238 were detected. The presence of Ac-227 was inferred by the detection of one or more associated radionuclides. When associated radionuclides of principal radionuclides detected were also detected, the highest detected concentration of either the associated or principal radionuclide was assigned to the principal. Complete background data is provided in **Appendix D**.

Comparison to Background

Summary statistics of the background data compared to the SEAD-63 soil data are presented in **Table 2-5**. Statistics were calculated by assigning one-half the detection limit for a non-detect value. The maximum value, however, was reported as the maximum detected value (i.e. non-detect values are not considered when detection limit exceeded maximum detected value). Background data are used in two ways to evaluate the site data. First, the summary statistics for the background and SEAD-63 data sets are compared in **Table 2-5**. The mean for each isotope detected at SEAD-63 is below the mean for the same isotope calculated for background for Pb-210 and Ra-228. The mean value of Ra-226 and U-238 detected at the site slightly exceeded background averages for these same radioisotopes. Maximum values detected in the SEAD-63 samples were below the maximum detected in background.

Table 2-5
Comparison of Summary Statistics in Background Soil to SEAD-63 Soil for Radionuclides
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

Parameter	Units	No. of Samples		No. of Hits		Frequency		Minimum		Maximum(2)		Average		Median		Std Dev		Wilcoxon Mean Rank		Zrs	Z(1-alpha	Reject Null Hypothesis?
		BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63			
Actinium-227(1)	pCi/g	32	0	8	NR	25%	0%	0.05	NR	0.40	NR	0.22	NR	0.20	NR	0.16	NR					
Cesium-137	pCi/g	38	14	12	14	32%	100%	0.05	-0.09	0.70	0.26	0.31	0.08	0.28	0.06	0.22	0.11					
Cobalt-57	pCi/g	38	0	5	NR	13%	0%	0.05	NR	0.10	NR	0.06	NR	0.05	NR	0.02	NR					
Cobalt-60	pCi/g	38	0	6	NR	16%	0%	0.05	NR	0.40	NR	0.13	NR	0.10	NR	0.08	NR					
Lead-210	pCi/g	38	14	5	14	13%	100%	0.60	1.40	4.30	2.10	5.76	1.76	3.03	1.70	5.22	0.23					
Plutonium-239/240	pCi/g	38	0	8	NA	21%	0%	0.05	NA	0.20	NA	0.12	NA	0.10	NR	0.05	NA					
Promethium 147	pCi/g	32	0	12	NA	38%	0%	2.10	NA	17.80	NA	6.98	NA	5.10	NA	4.47	NA					
Radium-226	pCi/g	38	14	29	14	76%	100%	0.60	1.1	2.60	1.6	1.34	1.36	1.40	1.40	0.47	1.36	25.39	25.83	0.0913	1.645	NO
Radium-228	pCi/g	38	14	37	14	97%	100%	1.00	0.92	3.50	1.30	1.76	1.11	1.70	1.10	0.51	0.13	30.51	9.63	-4.3365	1.645	NO
Thorium-228	pCi/g	0	14	0	14	0%	100%	NR	0.86	NR	1.80	NR	1.22	NR	1.20	NR	0.27					
Thorium-230	pCi/g	38	0	10	NR	26%	0%	0.20	NR	2.70	NR	0.78	NR	0.73	NR	0.48	NR					
Thorium-232	pCi/g	38	0	37	NR	97%	0%	0.45	NR	2.00	NR	0.99	NR	0.90	NR	0.36	NR					
Tritium	pCi/g	38	0	6	NA	16%	0%	0.05	NA	60.40	NA	2.31	NA	0.05	NA	10.05	NA					
Uranium-233/234	pCi/g	38	0	19	NR	50%	0%	0.20	NR	1.90	NR	0.63	NR	0.58	NR	0.33	NR					
Uranium-235	pCi/g	38	14	21	14	55%	100%	0.05	-0.09	0.40	0.26	0.11	0.06	0.10	0.08	0.08	0.09					
Uranium-238	pCi/g	38	14	28	14	74%	100%	0.15	0.40	1.40	1.10	0.70	0.69	0.70	0.67	0.32	0.26	25.58	25.25	-0.0684	1.645	NO
Gross Alpha	pCi/g	0	14	NA	14	0%	100%	NA	7	NA	17	NA	10.57	NA	10.5	NA	2.79					
Gross Beta	pCi/g	0	14	NA	14	0%	100%	NA	22	NA	42	NA	31.07	NA	31.5	NA	6.72					

(1) Actinium-227 is the principal radionuclide of Th-227. The value of Th-227 was assigned to Ac-227.
(2) Maximum Value Detected
NA - Not Analyzed
NR - Not Reported in Gamma Spectral Analysis Conducted During ESI
Only principal radionuclides shown.

Zrs = Statistic for radionuclide generated from Wilcoxon Rank Sum test
Z(1-alpha) = Maximum allowed probability that WRS test incorrectly indicates that the site and background datasets are distinguishable (alpha = 0.05)
Null Hypothesis: The populations from which the two data sets have been drawn have the same mean.

The Wilcoxon Rank Sum test (WRS test) was also used to compare the SEAD-63 soil dataset to the background soil data set. Radionuclides detected at the site that were shown to be drawn from the same mean as the background population were considered to be indistinguishable from background. The basis for this statistical comparison was obtained from the EPA Guidance document *Statistical Methods For Evaluating The Attainment Of Cleanup Standards* (EPA, 1994) and *Statistical Methods For Environmental Pollution Monitoring* (Gilbert, 1987).

The hypotheses used in the application of the WRS test are:

Ho (the null hypothesis):	The populations from which the two data sets have been drawn have the same mean.
Ha (the alternative hypothesis):	The measurements from the site population tend to exceed those from the background populations.

Where Ho is assumed to be true unless the test indicates Ho should be rejected in favor of Ha. If Ho cannot be rejected, then it is accepted that the distribution of measurements in the background area is very similar in shape and central tendency (average) to the distribution of measurements in the area being investigated. The WRS test does not require that either data set by normally distributed.

The WRS test is performed by first listing the combined background and SEAD-63 measurements from smallest to largest and assigning the ranks 1,2 etc., to the ordered values. The test handles non-detect values by treating them as ties. The methodology for treatment of ties recommended by Gilbert (1987) was followed. The ranks of the measurements from the cleanup unit are summed and used to compute the statistic Z_{rs}, which is compared to a critical value ($Z_{1-\alpha}$) from the standard normal distribution. The Z_{rs} statistic is calculated from the following formula:

$$Z_{RS} = \frac{W_{RS} - n(N+1)/2}{\left\{ \frac{mn}{12} \left[N + 1 - \frac{\sum_{j=1}^{g} t_j (t_j^2 - 1)}{N(N-1)} \right] \right\}^{1/2}}$$

where:

m = number of samples in the background data set
n = number of samples in the on-site data set
N = $m + n$
W_{rs} = the Wilcoxon Rank Sum of the on-site data set
g = the number of tied groups
t_j = the number of tied data in the jth group

The critical value $Z_{1-\alpha}$ defines the maximum allowed probability that the WRS test will incorrectly indicate that the site and background data sets are distinguishable. This type of error is called a Type I error and it denotes a 'false positive' evaluation. The overall Type I error rate (α) was selected as 0.05, which represents the 95% confidence interval. $Z_{1-\alpha}$ is found from Cumulative Standard Normal Distribution statistical tables. For a Type I error rate of 0.05, $Z_{1-\alpha}$ (or $Z_{.95}$) is equal to 1.645. If the calculated Z_{rs} statistic for a particular radionuclide is less than $Z_{1-\alpha}$ (1.645), the null hypothesis cannot be rejected. It is therefore concluded that, at the 95% confidence level, the measurements of that radionuclide in the on-site population do not tend to exceed the measurements of that radionuclide in the background population and that radionuclide is eliminated from the database.

The Wilcoxon Mean Rank for three radionuclides detected in SEAD-63 soil, Ra-226, Ra-228, and U-238, is shown in **Table 2-5.** Based on the results of the WRS test, these radionuclides were not distinguishable from background. The remaining radionuclides present in SEAD-63 soils had both average and maximum values less than those detected in background.

Comparison of Data to NYSDEC TAGM

According to NYSDEC TAGM Memorandum 4003, the total effective dose equivalent to the maximally exposed individual of the general public, from radioactivity material remaining at the site after cleanup, shall be as low as reasonably achievable and less than 10 mrem above that received from background levels of radiation in any one year.

Because the concentration of radionuclides detected in the soils at SEAD-63 were not distinguishable from background, the total effective dose equivalent due to exposure from soils at

SEAD-63 is not considered above background levels of radiation and therefore, are below NYSDEC TAGM.

2.6.4 Groundwater

Groundwater samples from three monitoring wells were collected as part of the ESI conducted at SEAD-63.

The summary of chemical analyses is presented in **Table 2-6**. The following sections describe the nature and extent of groundwater contamination identified at SEAD-63.

2.6.4.1 Volatile Organic Compounds

No volatile organic compounds were detected in the groundwater samples collected at SEAD-63.

2.6.4.2 Semivolatile Organic Compounds

Only one semivolatile organic compound, phenol, was detected in one of the three groundwater samples collected at SEAD-63. The phenol concentration of 2J mg/L detected in sample MW63-3 is above the TAGM value of 1 mg/L.

2.6.4.3 Pesticides and PCBs

No pesticides or PCBs were detected in the groundwater samples collected at SEAD-63.

2.6.4.4 Metals

Numerous metals were detected in the groundwater samples. Two metals, iron and manganese, were found in all three groundwater samples at concentrations above their respective state and/or federal criteria value. Iron was found in all three of the monitoring wells at concentrations between 603 mg/L and 1260 mg/L, which exceeded the state (and federal) criteria value of 300 mg/L. Manganese was found in all three of the monitoring wells at concentrations between 408 mg/L and 1070 mg/L and exceeds the NY AWQS standard of 300 mg/L.

Table 2-6
ESI Groundwater Analysis Results
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

		MAXIMUM	FREQUENCY OF DETECTION	NYS AWQS CLASS GA CRITERIA	NUMBER ABOVE CRITERIA	NUMBER OF DETECTS	NUMBER OF ANALYSES	GROUND WATER SEAD-63 MW63-1 7/11/94 MW63-1 SA	GROUND WATER SEAD-63 MW63-2 7/11/94 MW63-2 SA	GROUND WATER SEAD-63 MW63-3 7/11/94 MW63-3 SA
SVOCs										
Phenol	UG/L	2	33%	1	1	1	3	11 UJ	11 U	[redacted] J
METALS										
Aluminum	UG/L	747	100%		0	3	3	747	376	743
Barium	UG/L	83	100%	1000	0	3	3	72.6 J	71.2 J	83 J
Calcium	UG/L	295000	100%		0	3	3	89400	132000	295000
Chromium	UG/L	1.1	100%	50	0	3	3	1.1 J	0.91 J	1.1 J
Cobalt	UG/L	6.2	100%		0	3	3	6.2 J	2.4 J	6.2 J
Copper	UG/L	2.6	100%	200	0	3	3	2.1 J	1.4 J	2.6 J
Iron	UG/L	1260	100%	300	3	3	3	[redacted]	[redacted]	[redacted]
Lead	UG/L	1.1	33%	25	0	1	3	1.1 J	0.89 U	0.9 U
Magnesium	UG/L	54600	100%		0	3	3	16400	20000	54600
Manganese	UG/L	1070	100%	300	3	3	3	[redacted]	[redacted]	[redacted]
Mercury	UG/L	0	0%		0	0	3	0.04 U	0.04 U	0.04 U
Nickel	UG/L	10.6	100%		0	3	3	9.7 J	4.3 J	10.6 J
Potassium	UG/L	5340	100%		0	3	3	3870 J	2360 J	5340
Sodium	UG/L	146000	100%	20000	1	3	3	5710	5860	[redacted]
Vanadium	UG/L	1.5	100%		0	3	3	1.5 J	0.81 J	1.5 J
Zinc	UG/L	11.6	100%	300	0	3	3	7.1 J	6.2 J	11.6 J
Turbidity	NTUs							115	60	68
Conductivity	umhos							445	650	2100

No other significant concentrations of metals were detected in the groundwater samples collected at SEAD-63.

2.6.4.5 Radionuclides

The summary of radioactivity analysis results is presented in **Table 2-7**. No radionuclides from the uranium, thorium or actinium series were detected in the three groundwater samples submitted for gamma spectral analysis. Gamma radiation from K-40 was also undetected in the three groundwater samples.

Gross alpha radiation was detected at various levels in all three groundwater samples. Levels exceeded the radiological criteria for gross alpha radiation (15 pCi/L) in the groundwater at MW63-1 (27 pCi/L) and MW63-3 (130 pCi/L). Gross beta radiations were also detected in all three groundwater samples, ranging in levels from 7 to 130 pCi/L. None of the groundwater samples exceeded the NYS Class GA standard of 1,000 pCi/L of gross beta radiation.

Background levels for gross alpha ranged from 0.3 to 5.7 pCi/L and levels for gross beta ranged from 1 to 12.6 pCi/L. Background data is summarized in **Appendix D**. The higher levels of gross alpha and gross beta in the groundwater from SEAD-63 may be due to the relatively high turbidity of the samples collected. SEAD-63 groundwater samples had turbidity readings ranging from 60 to 115 NTUs. The turbidity of background samples, which were sampled using low flow pump purging and sampling techniques that minimize turbidity, ranged from 4.3 to 40 NTUs.

2.6.5 Surface Water

Four surface water samples were collected from the drainage ditch along Patrol Road during the ESI and eighteen (18) surface water samples were collected during RI field work conducted in December 1997. A summary of the chemical analyses is presented in **Table 2-8** along with the ESI data. The complete data set of surface water samples is included in **Appendix D**. The locations of the samples are shown in **Figure 2-5**. The following sections describe the nature and extent of surface water contamination identified at SEAD-63.

TABLE 2-7
GROUNDWATER RADIOACTIVITY ANALYSIS RESULTS SEAD-63 ESI
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

						MEDIA	WATER	WATER	WATER
						SWMU	SEAD-63	SEAD-63	SEAD-63
						DATE SAMPLED	7/11/1994	7/11/1994	7/11/1994
						ES ID	MW63-1	MW63-2	MW63-3
						LAB ID	226695	226696	226697
RADIONUCLIDE ANALYSIS GAMMA SPECTRAL	FREQUENCY OF DETECTION	NY AWQS CLASS GA	EPA MCLs	FEDERAL HEALTH ADVISORY	10 CFR 20 Appendix B Table 2	NUMBER ABOVE CRITERIA	pCi/L	pCi/L	pCi/L
GROSS ALPHA	100%	15 pCi/L	15 pCi/L	15 pCi/L	NA	2	27	4	130
GROSS BETA	100%	1000 pCi/L	4 mrem/year (note 2)	4 mrem/year (note 2)	NA	NA	51	7	130

NOTES:
1. U=not detected above this level.
2. The 4 mrem/year MCL is intended to be used as a screening device to measure for man-made radionuclides

2.6.5.1 Volatile Organic Compounds

Two volatile organic compounds were detected in the surface water samples collected at SEAD-63. Chloroform and toluene were detected at concentrations below the standard detection limits. There are no NYS AWQS Class C Standards for these compounds.

2.6.5.2 Semivolatile Organic Compounds

Sixteen semivolatile organic compounds were found in the surface water samples collected at SEAD-63; only two, pentachlorophenol and bis(2-ethylhexyl)phthalate were detected at concentrations which exceeded their respective New York State AWQS. Pentachlorophenol was detected in one sample, SW63-1, above the AWQS and bis(2-ethylhexyl)phthalate was detected in two samples above its AWQS. One exceedence of bis(2-ethylhexyl)phthalate slightly exceeded the AWQS (1J ug/L). The other exceedence occurred at SW63-3 and was detected at 68 ug/L which is over 100 times the AWQS (0.6 ug/L). SW63-3 is located north of the site along Patrol Road.

2.6.5.3 Pesticides and PCBs

Two pesticides were detected in the surface water at SEAD-63. Neither of the pesticides detected, endosulfan sulfate and endrin ketone, have New York State AWQS.

2.6.5.4 Metals

Several metals were detected in the surface water samples collected at the site. Aluminum, cobalt, iron, lead, and silver were detected above their respective AWQS for Class C surface waters in at least one sample. Aluminum was found in 10 samples exceeding the AWQS of 100 ug/L. The maximum hit was 36 times the AWQS. This maximum value was detected in SW63-2, where the maximum iron hit was detected (9050 ug/L), as well as cobalt and lead which were slightly above their AWQS. Silver was found in SW63-1 and SW63-3 at concentrations 5 to 9 times above its AWQS of 0.1 ug/L.

Table 2-8
ESI and Phase I RI Surface Water Analysis Results
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NYS AWQS CLASS C (AQUATIC)	NUMBER ABOVE AWQS	NUMBER OF DETECTS	NUMBER OF ANALYSES	SW63-1 SURFACE WATER SEAD-63 14-Jun-94 SWSD63-1 SW63-1 ESI	SW63-2 SURFACE WATER SEAD-63 12-Jun-94 SWSD63-2 SW63-2 ESI	SW63-3 SURFACE WATER SEAD-63 14-Jun-94 SWSD63-3 SW63-3 ESI	SW63-4 SURFACE WATER SEAD-63 13-Jun-94 SWSD63-4 SW63-4 ESI	63001 SURFACE WATER SEAD-63 4-Dec-97 SWSD63-7 63001 Phase I RI	63002 SURFACE WATER SEAD-63 5-Dec-97 SWSD63-11 63002 Phase I RI
VOCs													
Chloroform	UG/L	0 8	9 1%		0	2	22	10 U	10 U	10 U	10 U	1 U	1 U
Toluene	UG/L	1	4 5%		0	1	22	10 U	10 U	10 U	10 U	1 U	1 U
SVOCs													
4-Methylphenol	UG/L	0 22	4 5%		0	1	22	10 U	11 U	10 U	11 U	1 1 U	1 1 U
Benzo[a]pyrene	UG/L	1	4 5%		0	1	22	10 U	11 U	1 J	11 U	1.1 U	1 1 U
Benzo[b]fluoranthene	UG/L	0 9	4 5%		0	1	22	10 U	11 U	0 9 J	11 U	1.1 U	1.1 U
Benzo[ghi]perylene	UG/L	0 8	4 5%		0	1	22	10 U	11 U	0.8 J	11 U	1.1 U	1 1 U
Benzo[k]fluoranthene	UG/L	1	4 5%		0	1	22	10 U	11 U	1 J	11 U	1.1 U	1.1 U
Bis(2-Ethylhexyl)phthalate	UG/L	68	9 1%	0 6000	2	2	22	[illegible] J	11 U	[illegible]	11 U	1.1 U	1 8 U
Butylbenzylphthalate	UG/L	0 23	36.4%		0	8	22	10 U	11 U	10 U	11 U	0.13 J	1.1 U
Di-n-butylphthalate	UG/L	0.15	59 1%		0	13	22	10 U	11 U	10 U	11 U	0 059 J	0 059 J
Dibenz[a,h]anthracene	UG/L	0.8	4.5%		0	1	22	10 U	11 U	0.8 J	11 U	1.1 U	1.1 U
Diethyl phthalate	UG/L	0.29	27 3%		0	6	22	10 U	11 U	10 U	11 U	0 29 J	1.1 U
Fluoranthene	UG/L	0.7	9.1%		0	2	22	0.7 J	11 U	10 U	11 U	1.1 U	1.1 U
Indeno[1,2,3-cd]pyrene	UG/L	0 9	4 5%		0	1	22	10 U	11 U	0 9 J	11 U	1.1 U	1.1 U
Pentachlorophenol	UG/L	1	4 5%	0.4000	1	1	22	[illegible] J	27 U	25 U	27 U	2.6 U	2.7 U
Phenanthrene	UG/L	0.057	4 5%		0	1	22	10 U	11 U	10 U	11 U	1.1 U	1.1 U
Phenol	UG/L	0.8	9.1%	5.0000	0	2	22	10 U	0 8 J	10 U	0.8 J	1.1 U	1.1 U
Pyrene	UG/L	0.5	9 1%		0	2	22	0.5 J	11 U	10 U	11 U	1.1 U	1.1 U
PEST/PCBs													
Endosulfan sulfate	UG/L	0.014	4.5%		0	1	22	0 11 U	0 11 UJ	0.1 UJ	0.11 U	0 014 P	0.012 U
Endrin ketone	UG/L	0.046	22.7%		0	5	22	0 11 U	0 11 UJ	0 1 UJ	0 11 U	0 02	0 046
METALS													
Aluminum	UG/L	3630	68 2%	100 0000	10	15	22	[illegible] J	[illegible]	[illegible]	[illegible]	[illegible]	12 3 U
Arsenic	UG/L	3.8	4 5%	190 0000	0	1	22	2 U	3 8 J	2 U	2 U	3 6 U	3 6 U
Barium	UG/L	91 4	100 0%		0	22	22	27 9 J	91 4 J	26.4 J	43 1 J	19 B	15 2 B
Beryllium	UG/L	0.19	27 3%	1.1110	0	6	22	0.1 U	0 1 U	0.1 U	0 1 U	0.1 U	0 13 B
Cadmium	UG/L	0 78	9 1%	1 8628	0	2	22	0 2 U	0 78 J	0 2 U	0 2 U	0 3 U	0 3 U
Calcium	UG/L	220000	100 0%		0	22	22	89100	220000	75300	122000	26500	58900
Chromium	UG/L	5 6	22 7%	347 2701	0	5	22	0 66 J	5 6 J	1 J	0 68 J	1.1 U	1.1 U
Cobalt	UG/L	7 2	18 2%	5 0000	1	4	22	1 2 J	[illegible] J	0 5 U	0.99 J	1.7 U	1 7 U
Copper	UG/L	7.9	31.8%	20 2877	0	7	22	4 8 J	7 9 J	5 8 J	2.8 J	2.3 U	2 3 U
Iron	UG/L	9050	72.7%	300 0000	7	16	22	148	[illegible]	282	[illegible]	[illegible]	25.6 U
Lead	UG/L	20	9.1%	7.1636	1	2	22	0 9 U	[illegible]	0 9 U	0.9 U	1.8 U	1.8 U
Magnesium	UG/L	33700	100 0%		0	22	22	12900	33700	9640	18700	5560	9860
Manganese	UG/L	2300	100 0%		0	22	22	101	2300	7 3 J	1200	650	0.6 B
Mercury	UG/L	0.1	13.6%		0	3	22	0.03 U	0 04 J	0.1 J	0.03 J	0.1 U	0 1 U
Nickel	UG/L	18.8	40 9%	154 4886	0	9	22	2.5 J	18 8 J	2.3 J	2 J	2 3 U	2.3 U
Potassium	UG/L	11600	100 0%		0	22	22	3420 J	7910	4200 J	1660 J	5640	2700 B
Silver	UG/L	0 89	9.1%	0.1000	2	2	22	[illegible] J	0 5 U	[illegible] J	0 5 U	2.1 U	2.1 U
Sodium	UG/L	59300	100 0%		0	22	22	59300	30700	55100	25400	2230 B	11400
Thallium	UG/L	1.9	4.5%	8 0000	0	1	22	1 9 J	1.9 U	1 9 U	1.9 U	6 3 U	6 3 U
Vanadium	UG/L	8.9	18.2%	14 0000	0	4	22	1 6 J	8 9 J	1 4 J	1.1 J	1.6 U	1.6 U
Zinc	UG/L	99	100 0%	141.3798	0	22	22	2 5 J	99	2 2 J	12.2 J	16.2 B	5.1 B
Turbidity	NTUs							6	212	8 8	33	25.7	1.93

Table 2-8
ESI and Phase I RI Surface Water Analysis Results
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NYS AWQS CLASS C (AQUATIC)	NUMBER ABOVE AWQS	NUMBER OF DETECTS	NUMBER OF ANALYSES	63003 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-9 63003 Phase I RI	63004 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-6 63004 Phase I RI	63005 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-12 63005 Phase I RI	63006 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-16 63006 Phase I RI	63007 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-17 63007 Phase I RI	63008 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-18 63008 Phase I RI
VOCs													
Chloroform	UG/L	0 8	9 1%		0	2	22	1 U	1 U	1 U	0 5 J	1 U	1 U
Toluene	UG/L	1	4 5%		0	1	22	1 U	1 U	1 U	1 U	1 U	1
SVOCs													
4-Methylphenol	UG/L	0 22	4 5%		0	1	22	1 U	1 U	0 22 J	1 1 U	1 U	1 1 U
Benzo[a]pyrene	UG/L	1	4 5%		0	1	22	1 U	1 U	1 1 U	1 1 U	1 U	1 1 U
Benzo[b]fluoranthene	UG/L	0 9	4 5%		0	1	22	1 U	1 U	1 1 U	1 1 U	1 U	1 1 U
Benzo[ghi]perylene	UG/L	0 8	4 5%		0	1	22	1 U	1 U	1 1 U	1.1 U	1 U	1 1 U
Benzo[k]fluoranthene	UG/L	1	4 5%		0	1	22	1 U	1 U	1 1 U	1.1 U	1 U	1 1 U
Bis(2-Ethylhexyl)phthalate	UG/L	68	9 1%	0 6000	2	2	22	1 U	1 U	1 1 U	1 1 U	1 U	1 1 U
Butylbenzylphthalate	UG/L	0 23	36 4%		0	8	22	0 12 JB	1 U	0 23 JB	1.1 U	1 U	1 1 U
Di-n-butylphthalate	UG/L	0 15	59 1%		0	13	22	1 U	0 055 JB	1 1 U	0 15 JB	0 15 JB	0 1 JB
Dibenz[a,h]anthracene	UG/L	0 6	4 5%		0	1	22	1 U	1 U	1 1 U	1 1 U	1 U	1 1 U
Diethyl phthalate	UG/L	0 29	27 3%		0	6	22	1 U	1 U	0 13 JB	0 071 JB	0 074 JB	1 1 U
Fluoranthene	UG/L	0 7	9 1%		0	2	22	1 U	1 U	1 1 U	1.1 U	1 U	0 092 J
Indeno[1,2,3-cd]pyrene	UG/L	0.9	4 5%		0	1	22	1 U	1 U	1 1 U	1.1 U	1 U	1 1 U
Pentachlorophenol	UG/L	1	4 5%	0 4000	1	1	22	2 8 U	2 5 U	2 7 U	2 7 U	2 6 U	2 8 U
Phenanthrene	UG/L	0 057	4 5%		0	1	22	1 U	1 U	1 1 U	1.1 U	1 U	0 057 J
Phenol	UG/L	0 8	9 1%	5 0000	0	2	22	1 U	1 U	1 1 U	1 1 U	1 U	1.1 U
Pyrene	UG/L	0 5	9 1%		0	2	22	1 U	1 U	1 1 U	1.1 U	1 U	0 068 J
PEST/PCBs													
Endosulfan sulfate	UG/L	0 014	4 5%		0	1	22	0 01 U	0 01 U	0 011 U	0 011 U	0 011 U	0 011 U
Endrin ketone	UG/L	0 046	22 7%		0	5	22	0 01 U	0 01 U	0 011 U	0 011 U	0 011 U	0 011 U
METALS													
Aluminum	UG/L	3630	68 2%	100 0000	10	15	22	[illegible] B	41 7 B	98 7 B	30.1 B	12 3 U	[illegible]
Arsenic	UG/L	3 6	4 5%	190 0000	0	1	22	3 6 U	3 6 U	3 6 U	3 6 U	3 6 U	3 6 U
Barium	UG/L	91 4	100 0%		0	22	22	19 4 B	20 5 B	42 1 B	25 8 B	29 5 B	36 6 B
Beryllium	UG/L	0.19	27.3%	1 1110	0	6	22	0 11 B	0 1 U	0 1 U	0.1 U	0 17 B	0 16 B
Cadmium	UG/L	0.76	9 1%	1 8628	0	2	22	0.3 U	0 3 U	0.3 U	0.52 B	0 3 U	0 3 U
Calcium	UG/L	220000	100 0%		0	22	22	46200	37200	57100	84200	129000	83100
Chromium	UG/L	5 6	22 7%	347 2701	0	5	22	1 1 U	1 1 U	1 1 U	1 1 U	1.1 U	1 2 B
Cobalt	UG/L	7 2	18 2%	5.0000	1	4	22	1 7 U	1 7 U	2 2 B	1.7 U	1 7 U	1 7 U
Copper	UG/L	7 9	31.8%	20 2877	0	7	22	2 3 U	2 3 U	2 4 B	2.3 U	2 3 U	2 5 B
Iron	UG/L	9050	72 7%	300 0000	7	16	22	247	136	[illegible]	86.1 B	25 6 U	[illegible]
Lead	UG/L	20	9 1%	7.1638	1	2	22	1 8 U	1 8 U	1 8 U	1 8 U	1 8 U	1 8 U
Magnesium	UG/L	33700	100 0%		0	22	22	7610	7540	9410	8750	18300	10200
Manganese	UG/L	2300	100 0%		0	22	22	43 6	655	1930	126	5 6 B	95 9
Mercury	UG/L	0.1	13 6%		0	3	22	0 1 U	0 1 U	0 1 U	0 1 U	0 1 U	0 1 U
Nickel	UG/L	16 6	40 9%	154 4886	0	9	22	2 3 U	2 3 U	3 B	2 3 U	2 6 B	2 9 B
Potassium	UG/L	11600	100 0%		0	22	22	2740 B	5990	6620	4150 B	4170 B	11600
Silver	UG/L	0 69	9 1%	0 1000	2	2	22	2 1 U	2 1 U	2 1 U	2 1 U	2 1 U	2 1 U
Sodium	UG/L	59300	100 0%		0	22	22	15800	2660 B	2660 B	1120 B	6140	10400
Thallium	UG/L	1 9	4 5%	8 0000	0	1	22	6 3 U	6 3 U	6 3 U	6 3 U	6 3 U	6 3 U
Vanadium	UG/L	8 9	18 2%	14 0000	0	4	22	1 6 U	1 6 U	1 6 U	1 6 U	1 6 U	1 6 U
Zinc	UG/L	99	100 0%	141.3798	0	22	22	4 7 B	5 B	14 9 B	6 7 B	4 9 B	13 1 B
Turbidity	NTUs							1 96	3 43	9 21	4.32	0.98	16 5

Table 2-8
ESI and Phase I RI Surface Water Analysis Results
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NYS AWQS CLASS C (AQUATIC)	NUMBER ABOVE AWQS	NUMBER OF DETECTS	NUMBER OF ANALYSES	63009 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-19 63009 Phase I RI	63010 SURFACE WATER SEAD-63 11-Dec-97 SWSD63-20 63010 Phase I RI	63011 SURFACE WATER SEAD-63 12-Dec-97 SWSD63-14 63011 Phase I RI	63012 SURFACE WATER SEAD-63 12-Dec-97 SWSD63-10 63012 Phase I RI	63013 SURFACE WATER SEAD-63 12-Dec-97 SWSD63-15 63013 Phase I RI	63014 SURFACE WATER SEAD-63 12-Dec-97 SWSD63-8 63014 Phase I RI
VOCs													
Chloroform	UG/L	0 8	9.1%		0	2	22	1 U	1 U	1 U	1 U	1 U	0 8 J
Toluene	UG/L	1	4 5%		0	1	22	1 U	1 U	1 U	1 U	1 U	1 U
SVOCs													
4-Methylphenol	UG/L	0 22	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 2 U	1.1 U	1 2 U
Benzo[a]pyrene	UG/L	1	4 5%		0	1	22	1 U	1 1 U	1 1 U	1.2 U	1.1 U	1 2 U
Benzo[b]fluoranthene	UG/L	0.9	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 2 U	1 1 U	1 2 U
Benzo[ghi]perylene	UG/L	0.8	4 5%		0	1	22	1 U	1 1 U	1 1 U	1.2 U	1 1 U	1.2 U
Benzo[k]fluoranthene	UG/L	1	4 5%		0	1	22	1 U	1.1 U	1.1 U	1 2 U	1 1 U	1 2 U
Bis(2-Ethylhexyl)phthalate	UG/L	68	9 1%	0 6000	2	2	22	1 U	1 1 U	1 1 U	1 2 U	1.1 U	1 2 U
Butylbenzylphthalate	UG/L	0 23	36 4%		0	8	22	0 092 JB	1 1 U	0.19 J	0 21 J	0 19 J	1.2 U
Di-n-butylphthalate	UG/L	0.15	59.1%		0	13	22	1 U	0 08 JB	0 062 J	0 075 J	0.14 J	0 095 J
Dibenz[a,h]anthracene	UG/L	0 8	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 2 U	1 1 U	1 2 U
Diethyl phthalate	UG/L	0 29	27 3%		0	6	22	1 U	1 1 U	1.1 U	1 2 U	0.059 J	1 2 U
Fluoranthene	UG/L	0.7	9.1%		0	2	22	1 U	1 1 U	1 1 U	1.2 U	1 1 U	1 2 U
Indeno[1,2,3-cd]pyrene	UG/L	0 9	4 5%		0	1	22	1 U	1 1 U	1.1 U	1.2 U	1 1 U	1 2 U
Pentachlorophenol	UG/L	1	4 5%	0 4000	1	1	22	2 6 U	2 7 U	2.7 U	3.1 U	2.8 U	2 9 U
Phenanthrene	UG/L	0 057	4 5%		0	1	22	1 U	1 1 U	1 1 U	1.2 U	1 1 U	1 2 U
Phenol	UG/L	0 8	9 1%	5 0000	0	2	22	1 U	1.1 U	1 1 U	1 2 U	1 1 U	1 2 U
Pyrene	UG/L	0.5	9.1%		0	2	22	1 U	1 1 U	1.1 U	1 2 U	1.1 U	1 2 U
PEST/PCBs													
Endosulfan sulfate	UG/L	0 014	4 5%		0	1	22	0 01 U	0 011 U	0 012 U	0 013 U	0 0058 U	0 01 U
Endrin ketone	UG/L	0 046	22 7%		0	5	22	0 01 U	0 011 U	0 012 U	0 017	0 013	0 01 U
METALS													
Aluminum	UG/L	3630	68 2%	100 0000	10	15	22	12 3 U	30 B	12 3 U	12 3 U	[illegible]	25.9 B
Arsenic	UG/L	3 8	4 5%	190 0000	0	1	22	3 6 U	3.6 U	3 6 U	3 6 U	3 6 U	3 6 U
Barium	UG/L	91 4	100 0%		0	22	22	31 3 B	25 5 B	27.4 B	27 4 B	29 3 B	26 9 B
Beryllium	UG/L	0.19	27.3%	1.1110	0	6	22	0 19 B	0 18 B	0 1 U	0 1 U	0.1 U	0 1 U
Cadmium	UG/L	0.78	9 1%	1.8628	0	2	22	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0.3 U
Calcium	UG/L	220000	100 0%		0	22	22	134000	86400	128000	95200	88200	74200
Chromium	UG/L	5 6	22 7%	347 2701	0	5	22	1 1 U	1.1 U	1 1 U	1 1 U	1.1 U	1.1 U
Cobalt	UG/L	7 2	18.2%	5 0000	1	4	22	1 7 U	1.7 U	1 7 U	1.7 U	1.7 U	1 7 U
Copper	UG/L	7.9	31 8%	20 2877	0	7	22	2 3 U	2 5 B	2 3 U	2 3 U	2 3 U	2 3 U
Iron	UG/L	9050	72.7%	300 0000	7	16	22	25 6 U	59 5 B	25 6 U	25 6 U	[illegible]	82 B
Lead	UG/L	20	9.1%	7 1638	1	2	22	1 8 U	1 8 U	1 8 U	1 8 U	1.8 U	1 8 U
Magnesium	UG/L	33700	100 0%		0	22	22	18900	12200	20200	13300	12700	8080
Manganese	UG/L	2300	100.0%		0	22	22	6 1 B	2 7 B	3 7 B	0 83 B	7.7 B	47 2
Mercury	UG/L	0.1	13.6%		0	3	22	0.1 U	0 1 U	0 1 U	0 1 U	0 1 U	0.1 U
Nickel	UG/L	18.8	40.9%	154 4886	0	9	22	2 3 U	2.5 B	2.1 U	2.1 U	2.1 U	2.1 U
Potassium	UG/L	11600	100.0%		0	22	22	4450 B	5010	3160 B	5900	5690	4810 B
Silver	UG/L	0.89	9.1%	0 1000	2	2	22	2 1 U	2.1 U	2.1 U	2 1 U	2.1 U	2 1 U
Sodium	UG/L	59300	100 0%		0	22	22	8660	23800	13100	22400	26700	12300
Thallium	UG/L	1.9	4 5%	8 0000	0	1	22	6.3 U	6 3 U	6 3 U	6 3 U	6 3 U	6 3 U
Vanadium	UG/L	6.9	18 2%	14 0000	0	4	22	1 6 U	1 6 U	1 6 U	1 6 U	1 6 U	1 6 U
Zinc	UG/L	99	100 0%	141.3798	0	22	22	4 1 B	5 1 B	13 2 B	10 3 B	24 9	11 5 B
Turbidity	NTUs							0 57	0 86	0 68	0.46	4.18	2 08

Table 2-8
ESI and Phase I RI Surface Water Analysis Results
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NYS AWQS CLASS C (AQUATIC)	NUMBER ABOVE AWQS	NUMBER OF DETECTS	NUMBER OF ANALYSES	63015 SURFACE WATER SEAD-63 12-Dec-97 SWSD63-5 63015 Phase I RI	63016 SURFACE WATER SEAD-63 13-Dec-97 SWSD63-13 63016 Phase I RI	12214 SURFACE WATER SEAD-63 4-Dec-97 SWSD63-7 12214 Phase I RI	12216 SURFACE WATER SEAD-63 12-Dec-97 SWSD63-14 12216 Phase I RI
VOCs											
Chloroform	UG/L	0 8	9 1%		0	2	22	1 U	1 U	1 U	1 U
Toluene	UG/L	1	4 5%		0	1	22	1 U	1 U	1 U	1 U
SVOCs											
4-Methylphenol	UG/L	0 22	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 1 U
Benzo[a]pyrene	UG/L	1	4 5%		0	1	22	1 U	1 1 U	1 1 U	1.1 U
Benzo[b]fluoranthene	UG/L	0 9	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 1 U
Benzo[ghi]perylene	UG/L	0 8	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 1 U
Benzo[k]fluoranthene	UG/L	1	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 1 U
Bis(2-Ethylhexyl)phthalate	UG/L	68	9 1%	0 6000	2	2	22	1 U	1 1 U	1 6 U	1 1 U
Butylbenzylphthalate	UG/L	0 23	36 4%		0	8	22	1 U	1 1 U	0 092 J	1 1 U
Di-n-butylphthalate	UG/L	0 15	59 1%		0	13	22	1 U	0 13 J	0 071 J	1 1 U
Dibenz[a,h]anthracene	UG/L	0 8	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 1 U
Diethyl phthalate	UG/L	0 29	27 3%		0	6	22	1 U	1 1 U	0 093 J	1 1 U
Fluoranthene	UG/L	0 7	9 1%		0	2	22	1 U	1 1 U	1 1 U	1 1 U
Indeno[1,2,3-cd]pyrene	UG/L	0 9	4 5%		0	1	22	1 U	1 1 U	1 1 U	1.1 U
Pentachlorophenol	UG/L	1	4 5%	0 4000	1	1	22	2 5 U	2 7 U	2 8 U	2.7 U
Phenanthrene	UG/L	0 057	4 5%		0	1	22	1 U	1 1 U	1 1 U	1 1 U
Phenol	UG/L	0 8	9 1%	5 0000	0	2	22	1 U	1 1 U	1 1 U	1 1 U
Pyrene	UG/L	0 5	9.1%		0	2	22	1 U	1 1 U	1.1 U	1.1 U
PEST/PCBs											
Endosulfan sulfate	UG/L	0 014	4 5%		0	1	22	0 01 U	0 01 U	0 05 U	0 012 U
Endrin ketone	UG/L	0 046	22 7%		0	5	22	0 018	0 01 U	0 084 U	0 012 U
METALS											
Aluminum	UG/L	3630	68 2%	100 0000	10	15	22	[illegible]	12 3 U	[illegible] B	12 3 U
Arsenic	UG/L	3 8	4 5%	190 0000	0	1	22	3 6 U	3 6 U	3 6 U	3 6 U
Barium	UG/L	91 4	100 0%		0	22	22	12 9 B	26 B	16 5 B	26 5 B
Beryllium	UG/L	0 19	27 3%	1 1110	0	6	22	0 1 U	0 1 U	0 1 U	0.1 U
Cadmium	UG/L	0 78	9 1%	1 8628	0	2	22	0 3 U	0 3 U	0 3 U	0 3 U
Calcium	UG/L	220000	100 0%		0	22	22	40100	72500	26100	126000
Chromium	UG/L	5 6	22 7%	347 2701	0	5	22	1 1 U	1 1 U	1 1 U	1.1 U
Cobalt	UG/L	7.2	18 2%	5 0000	1	4	22	1 7 U	1 7 U	1 7 U	1.7 U
Copper	UG/L	7.9	31 8%	20 2877	0	7	22	2.3 U	2 3 U	2 3 U	2 3 U
Iron	UG/L	9050	72.7%	300 0000	7	16	22	[illegible]	49 8 B	150	25 6 U
Lead	UG/L	20	9 1%	7 1638	1	2	22	1 9 B	1 8 U	1 8 U	1 8 U
Magnesium	UG/L	33700	100 0%		0	22	22	6080	10600	5460	19800
Manganese	UG/L	2300	100 0%		0	22	22	89	48 5	198	3 8 B
Mercury	UG/L	0 1	13 6%		0	3	22	0 1 U	0 1 U	0 1 U	0.1 U
Nickel	UG/L	18 8	40 9%	154 4686	0	9	22	2 1 U	2 1 U	3 7 B	2 1 U
Potassium	UG/L	11600	100 0%		0	22	22	1660 B	1970 B	4980 B	2840 B
Silver	UG/L	0 89	9 1%	0 1000	2	2	22	2 1 U	2 1 U	2 1 U	2 1 U
Sodium	UG/L	59300	100 0%		0	22	22	19200	2440 B	2320 B	12600
Thallium	UG/L	1 9	4 5%	8 0000	0	1	22	6 3 U	6 3 U	6 3 U	6 3 U
Vanadium	UG/L	8 9	18 2%	14 0000	0	4	22	1 6 U	1 6 U	1 6 U	1 6 U
Zinc	UG/L	99	100 0%	141 3798	0	22	22	30 3	86 2	8 6 B	15 9 B
Turbidity	NTUs							1 67	1 75	25 7	0 68

2.6.5.5 Radioactivity

Table 2-9 presents the radioactivity analysis results for the surface water samples collected at SEAD-63. Principal radionuclides from the actinium, uranium and thorium series were detected in the twenty-two surface water samples submitted for radiological analysis. Principal radionuclides Ac-227, Co-60, K-40, Ra-226, Th-230, Th-232, Tritium, U-233/234, U-235, U-238, and Pm-147 were detected. The presence of Ac-227 was inferred by the presence of associated radionuclides Ra-223 and Th-227. When associated radionuclides are present, the highest detected concentration of either associated radionuclide or principal radionuclide was assigned to the principal radionuclide. Pm-147 was detected in one surface water sample.

Gross alpha radiation was detected in the 9 of the 22 surface water samples and gross beta radiation was detected in 12 of the 22 surface water samples. The levels of gross alpha and gross beta radiations in the samples were comparatively low (between 0 and 5 pCi/L for gross alpha and between 1.6U and 16 pCi/L for gross beta). The levels of gross alpha and gross beta in sample SW63-2 were significantly higher: gross alpha was detected at 75 pCi/L and gross beta was detected at 150 pCi/L. The turbidity of this sample was relatively high (212 NTUs) and may have contributed to the higher gross alpha and beta levels detected in this sample.

There are no Class C Surface Water Ambient Water Quality Standards established by New York State for radionuclides. However, the levels of radionuclides detected in the surface waters surrounding SEAD-63 were compared to background concentrations of radionuclides collected from the site. Summary statistics for both the background locations and SEAD-63 samples are shown in **Table 2-10** (background surface water locations and data are provided in **Appendix D**). Statistics were calculated as described in **Section 2.6.3.5**. All radionuclides detected in SEAD-63 surface water were detected in background samples except for Cobalt-60, Radium-226, Thorium-230, and Uranium-233/234. The maximum concentration of each radionuclide detected at SEAD-63 exceeded the maximum background concentration.

The Wilcoxon Rank Sum test described in **Section 2.6.3.5** was conducted on radionuclides from the SEAD-63 surface water data set and the background surface water data set. **Table 2-10** includes the Wilcoxon Mean Rank for SEAD-63 surface water samples and background samples. The results of the Wilcoxon Rank Sum test indicated that concentrations of Th-227 (daughter of

Table 2-9
Surface Water Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

PARAMETER	UNITS	SW63-1 ESI			SW63-2 ESI			SW63-3 ESI			SW63-4 ESI			SWSD63-10 63012 Phase I RI			SWSD63-11 63002 Phase I RI			SWSD63-12 63005 Phase I RI			SWSD63-13 63016 Phase I RI		
		VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/L		NR			NR			NR			NR		0 4	U	0 2	0 2	J	0 2	0 3	U	0 2	0 4		0 2
Cesium-137	pCi/L	12	ND		6	ND		12	ND		13	ND		1 6	U		1.1	U		3 6	U		3 2	U	
Cobalt-57	pCi/L		NR			NR			NR			NR		0 4	U		1 5	U		0 7	U		0 8	U	
Cobalt-60	pCi/L		NR			NR			NR			NR		2 7	U		,2	U		2 1	U		6 8	U	
Plutonium-239/240	pCi/L		NA			NA			NA			NA		0 4	U	0 2	0 3	U	0 2	0.1	U	0 1	0 2	U	0 1
Radium-226	pCi/L	145 5	ND		148 7	ND		164 4	ND		166 2	ND		0 4	U	0 1	0 5285	UJ	0.17	0 5285	UJ	0 23	0 4	U	0 1
Thorium-230	pCi/L		NR			NR			NR			NR		0 1	UJ	0 1	0 4	UJ	0 3	0 2	U	0 2	0 6	U	0 3
Thorium-232	pCi/L		NR			NR			NR			NR		0 2	U	0 1	0 3	UJ	0 1	0.1	U	0.1	0.2	U	0 1
Tritium	pCi/L		NA			NA			NA			NA		171	J	174	243	UJ	171	264	J	184	289	UJ	171
Uranium-233/234	pCi/L		NR			NR			NR			NR		0 7		0 4	0 6	U	0 3	0 4	UJ	0 3	0 5	J	0 4
Uranium-235	pCi/L	51.75	ND		53 85	ND		68 93	ND		66 76	ND		0 2	U	0 1	0 2	U	0.1	0 1	J	0 2	0 3	UJ	0 1
Uranium-238	pCi/L		NR			NR			NR			NR		0 4		0 3	0 2	UJ	0 2	0 2	J	0 2	0 3	J	0 3
Promethium 147	pCi/L		NA			NA			NA			NA			ND			ND			ND		66 9		40 3
Potassium-40	pCi/L	-18		68	130		80	12		60	-15		36		ND			ND			ND			ND	
Gross Alpha	pCi/L	1		3	75		32	0		3	5		6	0 2		1 8	1.9		1.4	0.3	U	0.9	2 3	U	1 3
Gross Beta	pCi/L	8		4	150		30	6		4	16		7	2 6	U	1 6	6 1	J	0 9	6 8		1 2	2 1	U	1 1

NOTES. Detected Principal Radionuclides only shown.
No surface water criteria for Class C Surface Waters are available for these radionuclides.
ND - Not detected, NR - Not reported, NA - Not analyzed.

Table 2-9
Surface Water Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

PARAMETER	UNITS	SWSD63-14 12216 Phase I RI - DU			SWSD63-14 63011 Phase I RI			SWSD63-15 63013 Phase I RI			SWSD63-16 63006 Phase I RI			SWSD63-17 63007 Phase I RI			SWSD63-18 63008 Phase I RI			SWSD63-19 63009 Phase I RI			SWSD63-20 63010 Phase I RI		
		VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/L	0 3	U	0.1	0 3	U	0 1	0 1	UJ	0 2	0 2	U	0 1	0 3	U	0.1	0 2	U	0 3	0.3	U	0 1	0 1		0 2
Cesium-137	pCi/L	2 8	U		8 6	U		4 3	U		2 5	U		1 8	U		1 5	U		1.7	U		3 8	U	
Cobalt-57	pCi/L	1.9	U		2 4	U		0.7	U		0 6	U		0 9	U		0.7	U		0.5	U		0 9	U	
Cobalt-60	pCi/L	6.2	U		4.7	U		2 6	U		2.3	U		7 4	U		1.1	U		3.5	U		4.4		2
Plutonium-239/240	pCi/L	0 1	U	0 1	0.1	U	0 2	0 1	U	0 1	0 4	U	0 2	0 1	U	0 2	0 2	U	0 3	0 2	U	0 2	0 2	U	0 2
Radium-226	pCi/L	0.3	J	0 2	0 1	J	0 2	0.4	U	0.1	0 5285	UJ	0 15	0 4	U	0 2	0 2	-	0 2	0.4	U	0.1	0 1		0 2
Thorium-230	pCi/L	0.2	UJ	0 2	0.1	UJ	0.1	0 3	UJ	0 3	0 2	U	0 2	0 1	UJ	0 1	0.1	UJ	0 2	0.2		0 2	0 2	U	0 2
Thorium-232	pCi/L	0 1	J	0 1	0.1	UJ	0 1	0 2	J	0 2	0 1	U	0 1	0 1		0 1	0 2	U	0.1	0.1	UJ	0 1	0 1	UJ	0 1
Tritium	pCi/L	243	J	177	171	J	174	81.1	J	170	234	J	176	225	J	174	140	J	171	185	J	170	167	J	173
Uranium-233/234	pCi/L	1 9	J	0 6	0 9	J	0 4	0 6		0 3	0 5		0 3	1 2	J	0 6	0 6		0.4	0 8		0 3	0 7		0 3
Uranium-235	pCi/L	0 2	J	0 2	0.1	J	0.1	0.1		0.1	0 1		0 1	0 1	J	0.1	0 3	U	0.1	0.2	U	0.1	0 2		0 2
Uranium-238	pCi/L	0 7	J	0 4	0 4	J	0 2	0 5		0 3	0 4		0 2	0 6	J	0.4	0.3		0 2	0.4		0 2	0.4		0 2
Promethium 147	pCi/L		ND			ND			ND			ND			ND			ND			ND			ND	
Potassium-40	pCi/L		ND			ND			ND			ND			ND			ND			ND			ND	
Gross Alpha	pCi/L	3 8	UJ	2 3	0 4	J	2 3	0 2		2	2 2	U	1 3	3 6	U	2	2 7	U	1 6	3 7	U	2 2	4 4	U	2 6
Gross Beta	pCi/L	3 4	U	1 6	3 9	U	2	4	U	2 2	6 9		1 5	3 6	U	2 1	8 4		1.7	3 8	U	2.1	3 2	U	1 8

Table 2-9
Surface Water Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

		SWSD63-5 63015 Phase I RI			SWSD63-6 63004 Phase I RI			SWSD63-7 12214 Phase I RI -DU			SWSD63-7 63001 Phase I RI			SWSD63 8 63014 Phase I RI			SWSD63-9 63003 Phase I RI		
PARAMETER	**UNITS**	**VALUE**	**QUAL**	**ERROR**	**VALUE**	**QUAL**	**ERROR**	**VALUE**	**QUAL**	**ERROR**	**VALUE**	**QUAL**	**ERROR**	**VALUE**	**QUAL**	**ERROR**	**VALUE**	**QUAL**	**ERROR**
Actinium-227	pCi/L	0 2	U	0 2	0 4	U	0 2	0 1	J	0 1	0 2	UJ	0 1	0 3	J	0 3	0 1	UJ	0 2
Cesium-137	pCi/L	1	U		4	U		1 4	U		0 4	U		5 8	U		5	U	
Cobalt-57	pCi/L	0 8	U		0 6	U		0 6	U		0 2	U		1	U		1	U	
Cobalt-60	pCi/L	3 2	U		3 8		1 3	0 4	UJ		2 8	J	0 7	9 8		4 6	7 7	U	
Plutonium-239/240	pCi/L	0.1	U	0 1	0 2	U	0 2	0 3	U	0 2	0 2	U	0 2	0 2	U	0 2	0 2	U	0 2
Radium-226	pCi/L	0 2		0 2	0 5285	UJ	0 18	0 5285	UJ	0 19	0 2	J	0 3	0 4	U	0 1	0 5285	UJ	0 18
Thorium-230	pCi/L	0 4	U	0 3	0 6		0 3	0 4	U	0 3	0 4	UJ	0 1	0 6	UJ	0 4	0 2	UJ	0 2
Thorium-232	pCi/L	0 1	U	0 2	0 1		0.1	0 2	UJ	0 1	0 1	J	0.2	0 2	J	0 2	0 1	U	0 1
Tritium	pCi/L	176	J	186	167	J	177	225	J	174	198	UJ	172	140	J	193	225	J	171
Uranium-233/234	pCi/L	0 2	UJ	0 2	0 3	U	0 1	0 2	U	0 2	0 1	U	0 2	0 4	UJ	0 3	0 3	U	0 2
Uranium-235	pCi/L	0 1		0 1	0 3	U	0 1	0 2	U	0 1	0 2	U	0 1	0 1		0 1	0 1		0 1
Uranium-238	pCi/L	0 2		0 1	0 3	U	0 1	0 1	UJ	0 1	0 2	UJ	0.1	0 1		0 1	0 1		0 1
Promethium 147	pCi/L		ND			ND			ND			ND			ND			ND	
Potassium-40	pCi/L		ND			ND			ND			ND			ND			ND	
Gross Alpha	pCi/L	1 8	U	1	1 3	U	0 7	0 3	U	0 5	0 4	U	0 6	0 2		1 6	0 3	U	1
Gross Beta	pCi/L	1 6	U	0 9	5 6		1	7 3	J	0 7	6 5	J	0 6	2 5	U	1 4	5 7		1 4

Table 2-10
Comparison of Summary Statistics in Background Surface Water to SEAD-63 Surface Water for Radionuclides
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

Parameter	Unit	No. of Samples		No. of Hits		Frequency		Minimum		Maximum Detected Value		Average		Median		Std Dev		Wilcoxen Mean Rank		Zrs	Z(1-alpha)	Reject Null Hypothesis?
		BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63			
Actinium-227 (1)	pCi/L	9	18	3	5	33%	28%	0 10	0 05	0 01	0 40	0 11	0 15	0 10	0 15	0 02	0 09	10 61	15 69	1 7027	1 645	YES
Cobalt-57	pCi/L	9	18	0	0	0%	0%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Cobalt-60	pCi/L	9	18	0	4	0%	22%	ND	0 20	ND	9 80	ND	2 61	ND	2 05	ND	2 20					
Cesium-137	pCi/L	9	18	0	0	0%	0%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Plutonium-239/240	pCi/L	9	18	0	0	0%	0%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Promethium147	pCi/L	9	1	4	1	44%	100%	0 00	66 90	61 30	66 90	30 31	66 90	31 95	66 90	21 24						
Radium-226	pCi/L	9	18	0	6	0%	33%	ND	0 10	ND	0 30	ND	0 22	ND	0 20	ND	0 05					
Thorium-230	pCi/L	9	18	0	2	0%	11%	ND	0 05	ND	0 60	ND	0 17	ND	0 13	ND	0 13					
Thorium-232	pCi/L	9	18	2	6	22%	33%	0 10	0 05	0 10	0 20	0 11	0 09	0 10	0 10	0 02	0 05	16 5	12 75	-1 3148	1 645	NO
Tritium	pCi/L	9	18	4	15	44%	83%	13 50	81 10	158 00	284 00	88 60	177 73	76 50	171 00	53 01	53 38	7 06	17 47	3 2186	1 645	YES
Uranium-233/234	pCi/L	9	18	0	10	0%	56%	ND	0 05	ND	1 90	ND	0 54	ND	0 50	ND	0 47					
Uranium-235	pCi/L	9	22	6	10	67%	45%	0 05	0 10	0 10	33 47	0 09	5 54	0 10	0 10	0 02	11 86	10 06	18 43	2 7239	1 645	YES
Uranium-238	pCi/L	9	18	4	18	44%	100%	0 05	0 05	0 30	0 70	0 13	0 30	0 10	0 30	0 08	0 19	9	18 5	2 3589	1 645	YES
GrossAlpha	pCi/L	9	22	4	9	44%	41%	0 40	0 00	11 50	75 00	3 63	4 43	1 25	0 95	4 08	15 80	20 33	14 23	-1 7009	1 645	NO
GrossBeta	pCi/L	9	22	5	12	56%	55%	1 10	0 80	27 40	150 00	9 57	11 30	3 10	5 65	11 45	31 19	15 44	16 23	0 2177	1 645	NO

(1) Actinium-227 is the principal radionuclide of Th-227 The value of Th-227 was assigned to Ac-227

NA - Not Analyzed

NR - Not Reported in Gamma Spectral Analysis Conducted During ESI

Note When sample was reported as ND, one half the detection limit was assigned to the sample for the purposes of calculating statistics, except for the maximum value, which only considered detected values

Ac-227). Radon 222, tritium, U-235, and U-238 were distinguishable above background levels. All of these radionuclides are naturally occurring. Tritium's presence in the environment is also attributable to atmospheric weapons testing (Michel, 1995).

2.6.6 Sediment

A total of 22 sediment samples were collected during the ESI and the RI field work conducted in December 1997. These samples were collected in the same locations as the twenty-two surface water samples as shown in **Figure 2-5**. The summary of the chemical analyses is presented in **Table 2-11**. The complete data set for sediment data is provided in **Appendix D**. The following sections describe the nature and extent of sediment contamination identified at SEAD-63.

2.6.6.1 Volatile Organic Compounds

Three volatile organic compounds were detected at low concentrations in samples SD63-2 and SD63-3. The maximum concentrations of acetone, 2-butanone, and toluene were detected at concentrations of 150J mg/kg, 35J mg/kg and 14J mg/kg, respectively, in sample SD63-3. Acetone was detected in 6 other samples and 2-butanone was also found in SD63-2. No criteria exist for these VOCs in sediments.

2.6.6.2 Semivolatile Organic Compounds

A total of 21 SVOCs were identified in sediment samples collected at SEAD-63. Six of the SVOCs were detected at concentrations above their respective criteria in samples SD63-18 and SD63-19. Two of these SVOCs, benzo(a)pyrene and benzo(a)fluoranthene, were detected at a concentrations greater than twice the sediment criteria value.

2.6.6.3 Pesticides and PCBs

Six pesticide compounds were detected in five of the sediment samples. None of the pesticides was over its respective NYSDEC criteria value.

Table 2-11
ESI and Phase I RI Data Sediment
SEAD-63 EE/CA
Seneca Army Depot Activity

Parameter	Unit	aximum oncentration	requency of etection (%)	omparison evel (1)	omparison Level ype (1)	umber of Times alue Exceeds omparison Level	umber of Times etected	umber of amples	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q
						Area			SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
						Loc_Id			SWSD63-1		SWSD63-2		SWSD63-3		SWSD63-4		SWSD63-9		SWSD63-18		SWSD63-15		SWSD63-8	
						Matrix			SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
						Samp_Id			SD63-1		SD63-2		SD63-3		SD63-4		63103		63108		63113		63114	
						Sample Depth			0		0		0		0		0 2		0 2		0 2		0 2	
						Sample Depth			0 1		0 1		0 1		0 1		0 4		0 4		0 4		0 4	
						Sample Date			6/13/94		6/12/94		6/13/94		6/13/94		12/11/97		12/11/97		12/12/97		12/12/97	
						Sample Type			SA		SA		SA		SA		SA		SA		SA		SA	
						Study Id			ESI		ESI		ESI		ESI		P1S1		P1S1		P1S1		P1S1	
Volatile Organic Compounds																								
Acetone	UG/KG	150	0 42857			0	9	21	15	U	23	UJ	12	UJ	150	J	10	J	35	J	16	U	15	U
Methyl ethyl ketone	UG/KG	35	0 09524			0	2	21	15	U	8	J	12	UJ	35	J	18	U	17	U	16	U	15	U
Toluene	UG/KG	14	0 04762	1656	BALC	0	1	21	15	U	16	UJ	12	UJ	14	J	18	U	17	U	16	U	15	U
Semi-Volatile Organic Compounds																								
2-Methylnaphthalene	UG/KG	14	0 09524	1149	BALC	0	2	21	480	U	700	UJ	390	U	720	UJ	150	U	12	J	120	U	94	U
Acenaphthene	UG/KG	80	0 14286	4732	BALC	0	3	21	480	U	700	UJ	390	U	720	UJ	150	U	43	J	120	U	94	U
Acenaphthylene	UG/KG	82	0 14286			0	3	21	480	U	700	UJ	390	U	720	UJ	150	U	17	J	120	U	94	U
Anthracene	UG/KG	250	0 42857	3617	BALC	0	9	21	480	U	700	UJ	390	U	48	J	150	U	93	J	7 4	J	94	U
Benzo(a)anthracene	UG/KG	1600	0 95238	44	HHB	2	20	21	[illegible]	J	[illegible]	J	[illegible]	J	[illegible]	J	15	J	[illegible]		[illegible]	J	9 2	J
Benzo(a)pyrene	UG/KG	2900	0 95238	44	HHB	13	20	21	[illegible]	J	[illegible]	J	[illegible]	J	[illegible]	J	22	J	[illegible]		[illegible]	J	12	J
Benzo(b)fluoranthene	UG/KG	5300	0 95238	44	HHB	14	20	21	[illegible]	J	[illegible]	J	[illegible]	J	[illegible]	J	23	J	[illegible]	J	[illegible]		18	J
Benzo(ghi)perylene	UG/KG	2700	0 95238			0	20	21	38	J	71	J	37	J	230	J	18	J	750		74	J	11	J
Benzo(k)fluoranthene	UG/KG	570	0 66667	44	HHB	10	14	21	[illegible]	J	[illegible]	J	[illegible]	J	[illegible]	J	17	J	[illegible]		[illegible]	J	8 7	J
Bis(2-Ethylhexyl)phthalate	UG/KG	110	0 52381	6743	BALC	0	11	21	25	J	700	UJ	390	U	720	UJ	13	J	16	J	120	U	94	U
Butylbenzylphthalate	UG/KG	22	0 2381			0	5	21	480	U	700	UJ	390	U	720	UJ	150	U	120	U	120	U	94	U
Carbazole	UG/KG	430	0 47619			0	10	21	480	U	700	UJ	390	U	34	J	150	UJ	260	J	17	J	94	U
Chrysene	UG/KG	2300	0 95238	44	HHB	13	20	21	[illegible]	J	[illegible]	J	[illegible]	J	[illegible]	J	22	J	[illegible]		[illegible]	J	13	J
Di-n-butylphthalate	UG/KG	19	0 47619			0	10	21	480	U	700	UJ	390	U	720	UJ	9 5	J	120	U	6 4	J	94	U
Di-n-octylphthalate	UG/KG	19	0 04762			0	1	21	480	U	700	UJ	19	J	720	UJ	150	U	120	U	120	U	94	U
Dibenz(a,h)anthracene	UG/KG	1200	0 52381			0	11	21	480	U	700	UJ	390	U	140	J	150	U	250		12	J	94	U
Dibenzofuran	UG/KG	36	0 09524			0	2	21	480	U	700	UJ	390	U	720	UJ	150	U	36	J	120	U	94	U
Diethyl phthalate	UG/KG	92	0 33333			0	7	21	480	U	700	UJ	390	U	720	UJ	150	U	120	U	6 4	J	94	U
Fluoranthene	UG/KG	4100	0 95238	34476	BALC	0	20	21	110	J	240	J	100	J	720	J	31	J	1700	J	180		25	J
Fluorene	UG/KG	110	0 14286	270	BALC	0	3	21	480	U	700	UJ	390	U	720	UJ	150	U	79	J	120	U	94	U
Indeno(1,2,3-cd)pyrene	UG/KG	2500	0 95238	44	HHB	10	20	21	[illegible]	J	[illegible]	J	42	J	[illegible]	J	14	J	[illegible]		[illegible]	J	9 5	J
Naphthalene	UG/KG	23	0 09524	1014	BALC	0	2	21	480	U	700	UJ	390	U	720	UJ	160	U	21	J	120	U	94	U
Phenanthrene	UG/KG	1400	1	4056	BALC	0	21	21	49	J	120	J	60	J	270	J	12	J	940		56	J	11	J
Phenol	UG/KG	11	0 04762	17	BALC	0	1	21	480	U	700	UJ	390	U	720	UJ	150	U	120	U	120	U	94	U
Pyrene	UG/KG	3200	0 95238	32482	BALC	0	20	21	100	J	220	J	110	J	600	J	24	J	1300	J	120	J	17	J
Pesticides																								
4,4'-DDD	UG/KG	3 9	0 04762	0 338	HHB	1	1	21	4 9	UJ	7	UJ	3 9	UJ	[illegible]	J	7 3	U	5 9	U	6 2	U	4 7	U
4,4'-DDE	UG/KG	9 2	0 14286	0 338	HHB	3	3	21	4 9	UJ	[illegible]	J	3 9	UJ	[illegible]	J	7 3	U	5 9	U	6 2	U	4 7	U
4,4'-DDT	UG/KG	8 3	0 09524	0 338	HHB	2	2	21	4 9	UJ	7	UJ	3 9	UJ	[illegible]	J	7 3	U	5 9	U	6 2	U	4 7	U
Aroclor-1260	UG/KG	44	0 04762	0 02704	HHB	1	1	21	49	UJ	70	UJ	39	UJ	72	UJ	73	U	59	U	62	U	47	U
Endosulfan I	UG/KG	7 5	0 09524	1 014	BALC	2	2	21	2 5	UJ	[illegible]	J	[illegible]	J	3 7	UJ	3 8	U	3	U	3 2	U	2 4	U
Endosulfan sulfate	UG/KG	12	0 09524			0	2	21	4 9	UJ	7	UJ	3 9	UJ	5 2	J	7 3	U	5 9	U	6 2	U	4 7	U
Endrin ketone	UG/KG	9 4	0 04762			0	1	21	4 9	UJ	7	UJ	3 9	UJ	9 4	J	7 3	U	5 9	U	6 2	U	4 7	U
Metals																								
Aluminum	MG/KG	16700	1			0	21	21	7590		11700	J	11100		11000	J	11600		10900		12900		9090	
Arsenic	MG/KG	6 6	1	6	LEL	1	21	21	4 1		3 7	J	4 3		2 4	J	4 7		4 1		5		3 3	
Barium	MG/KG	107	1			0	21	21	36 3	J	63 5	J	37 2		90 6	J	65 1	J	59 8	J	70 9		62 7	
Beryllium	MG/KG	0 8	1			0	21	21	0 44	J	0 59	J	0 52	J	0 54	J	0 64	J	0 46	J	0 49		0 43	
Cadmium	MG/KG	0 83	0 19048	0 6	LEL	2	4	21	0 6	J	[illegible]	J	0 38	J	[illegible]	J	0 13	U	0 1	U	0 09	U	0 08	U
Calcium	MG/KG	211000	1			0	21	21	101000		69800	J	31500		34100	J	7050		34800		27300		103000	
Chromium	MG/KG	24 4	1	26	LEL	0	21	21	13 8	J	19 1	J	20 3	J	18 2	J	18 4		17 5		23 1		15 2	
Cobalt	MG/KG	14 4	1			0	21	21	10 6	J	11 9	J	11 2		10 5	J	10 7	J	9 3	J	12 8		6 9	
Copper	MG/KG	42 6	1	16	LEL	18	21	21	[illegible]		[illegible]	J	[illegible]		[illegible]	J	[illegible]		[illegible]		[illegible]		[illegible]	
Cyanide	MG/KG	2 1	0 04762			0	1	21	0 6	U	0 97	UJ	0 53	U	0 99	UJ	1 1	UJ	0 92	UJ	1	UJ	0 72	UJ
Iron	MG/KG	29700	1	20000	LEL	8	21	21	17100		19200	J	[illegible]		16700	J	[illegible]		17600		[illegible]		17200	
Lead	MG/KG	46 2	0 80952	31	LEL	5	17	21	33 5	UR	37 4	UR	27 5	UR	37 2	UR	26 5	J	[illegible]	J	[illegible]		17 2	
Magnesium	MG/KG	16100	1			0	21	21	15000		13900	J	6210		8590	J	5010		6280		9460		5850	
Manganese	MG/KG	995	1	460	LEL	9	21	21	449		[illegible]	J	260		[illegible]	J	264		344		[illegible]	J	255	J
Mercury	MG/KG	0 12	0 2381	0 15	LEL	0	5	21	0 04	J	0 06	J	0 03	J	0 12	J	0 11	UJ	0 07	UJ	0 09	U	0 07	U
Nickel	MG/KG	44 2	1	16	LEL	19	21	21	[illegible]		[illegible]	J	[illegible]		[illegible]	J	[illegible]		[illegible]		[illegible]		[illegible]	
Potassium	MG/KG	2570	1			0	21	21	1370	J	2570	J	1340	J	1670	J	1530	J	2290		1960		1260	
Selenium	MG/KG	2 1	0 28571			0	6	21	0 62	U	0 68	UJ	1 1		0 97	J	2	U	1 5	U	2 1		1 2	U
Sodium	MG/KG	578	0 80952			0	17	21	121	J	194	J	197	J	119	J	285	J	383	J	266		170	
Thallium	MG/KG	2 3	0 14286			0	3	21	0 44	U	0 48	UJ	0 34	U	0 62	UJ	2 7	UJ	2	UJ	2 3		1 6	U
Vanadium	MG/KG	28	1			0	21	21	19 9		27 5	J	19 1		21 2	J	20 4	J	21 2		24 3		17 3	
Zinc	MG/KG	534	1	120	LEL	5	21	21	105		[illegible]	J	68		[illegible]	J	79 2	J	90 6	J	[illegible]		66 6	

Notes
(1) BALC = Bent 's Chronic HHB = Human Health Bioaccumulation LEL = Lowest Effect Level

Table 2-11
ESI and Phase I RI Data Sediment
SEAD-63 EE/CA
Seneca Army Depot Activity

Parameter	Unit	aximum oncentration	requency of etection (%)	omparison evel (1)	omparison Level ype (1)	umber of Times alue Exceeds omparison Level	umber of Times etected	umber of amples	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q
Area									SEAD-63		SEAD-63		SEAD 63		SEAD-63		SEAD 63		SEAD-63		SEAD-63	
Loc_id									SWSD63 5		SWSD63-13		SWSD63 14		SWSD63 20		SWSD63 14		SWSD63-10		SWSD63-17	
Matrix									SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
Samp_Id									63115		63116		12217		63110		63111		63112		63107	
Sample Depth									0 2		0 2		0 3		0 3		0 3		0 3		0 3	
Sample Depth									0 4		0 4		0 5		0 5		0 5		0 5		0 6	
Sample Date									12/12/97		12/13/97		12/12/97		12/11/97		12/12/97		12/12/97		12/11/97	
Sample Type									SA		SA		DU		SA		SA		SA		SA	
Study Id									P1S1		P1S1		P1S1		P1S1		P1S1		P1S1		P1S1	
Volatile Organic Compounds																						
Acetone	UG/KG	150	0 42857			0	9	21	15	U	25		24	J	17	J	21	UJ	68	J	27	UJ
Methyl ethyl ketone	UG/KG	35	0 09524			0	2	21	15	U	14	U	17	U	16	U	18	U	14	U	27	U
Toluene	UG/KG	14	0 04762	1656	BALC	0	1	21	15	U	14	U	17	UJ	16	U	18	UJ	14	U	27	U
Semi-Volatile Organic Compounds																						
2-Methylnaphthalene	UG/KG	14	0 09524	1149	BALC	0	2	21	120	U	93	U	120	U	100	U	120	U	160	U	220	U
Acenaphthene	UG/KG	60	0 14286	4732	BALC	0	3	21	120	U	93	U	120	U	8 2	J	120	U	160	U	220	U
Acenaphthylene	UG/KG	82	0 14286			0	3	21	120	U	93	U	120	U	9 1	J	120	U	160	U	220	U
Anthracene	UG/KG	250	0 42857	3617	BALC	0	9	21	120	U	93	U	13	J	17	J	11	J	160	U	19	J
Benzo(a)anthracene	UG/KG	1800	0 95238	44	HHB	2	20	21	33	J	93	U	[illegible]		[illegible]		[illegible]	J	25	J	[illegible]	J
Benzo(a)pyrene	UG/KG	2900	0 95238	44	HHB	13	20	21	30	J	93	U	[illegible]		[illegible]		[illegible]		[illegible]	J	[illegible]	J
Benzo(b)fluoranthene	UG/KG	5300	0 95238	44	HHB	14	20	21	[illegible]	J	93	U	[illegible]		[illegible]		[illegible]		[illegible]	J	[illegible]	
Benzo(ghi)perylene	UG/KG	2700	0 95238			0	20	21	37	J	93	U	100	J	180		110	J	54	J	150	J
Benzo(k)fluoranthene	UG/KG	570	0 66667	44	HHB	10	14	21	33	J	93	U	[illegible]		[illegible]		[illegible]		160	U	[illegible]	J
Bis(2-Ethylhexyl)phthalate	UG/KG	110	0 52381	6743	BALC	0	11	21	120	U	93	U	120	U	12	J	120	U	160	U	22	J
Butylbenzylphthalate	UG/KG	22	0 2381			0	5	21	6 7	J	93	U	15	J	100	U	120	U	160	U	16	J
Carbazole	UG/KG	430	0 47619			0	10	21	15	J	93	U	24	J	28	J	19	J	160	U	32	J
Chrysene	UG/KG	2300	0 95238	44	HHB	13	20	21	43	J	93	U	[illegible]		[illegible]		[illegible]		[illegible]	J	[illegible]	J
Di-n butylphthalate	UG/KG	19	0 47619			0	10	21	8 5	J	12	J	120	U	100	U	120	U	8 8	J	11	J
Di-n-octylphthalate	UG/KG	19	0 04762			0	1	21	120	U	93	U	120	U	100	U	120	U	160	U	220	U
Dibenz(a,h)anthracene	UG/KG	1200	0 52381			0	11	21	8 8	J	93	U	34	J	84	J	28	J	160	U	46	J
Dibenzofuran	UG/KG	36	0 09524			0	2	21	120	U	93	U	120	U	100	U	120	U	160	U	220	U
Diethyl phthalate	UG/KG	92	0 33333			0	7	21	9 5	J	7 6	J	6 2	J	100	U	8 2	J	92	J	220	U
Fluoranthene	UG/KG	4100	0 95238	34476	BALC	0	20	21	82	J	93	U	250		400		250		43	J	360	
Fluorene	UG/KG	110	0 14286	270	BALC	0	3	21	120	U	93	U	120	U	10	J	120	U	160	U	220	U
Indeno(1,2,3-cd)pyrene	UG/KG	2500	0 95238	44	HHB	10	20	21	28	J	93	U	[illegible]	J	[illegible]		[illegible]	J	27	J	[illegible]	J
Naphthalene	UG/KG	23	0 09524	1014	BALC	0	2	21	120	U	93	U	120	U	100	U	120	U	160	U	220	U
Phenanthrene	UG/KG	1400	1	4056	BALC	0	21	21	35	J	6 4	J	88	J	120		60	J	37	J	120	J
Phenol	UG/KG	11	0 04762	17	BALC	0	1	21	120	U	93	U	11	J	100	U	120	U	160	U	220	U
Pyrene	UG/KG	3200	0 95238	32482	BALC	0	20	21	58	J	93	U	200		290		180		45	J	240	
Pesticides																						
4 4'-DDD	UG/KG	3 9	0 04762	0 338	HHB	1	1	21	5 9	U	4 6	U	5 9	U	5 2	U	6	U	2 1	U	11	U
4,4'-DDE	UG/KG	9 2	0 14286	0 338	HHB	3	3	21	5 9	U	4 6	U	5 9	U	5 2	U	6	U	[illegible]	J	11	U
4,4'-DDT	UG/KG	8 3	0 09524	0 338	HHB	2	2	21	5 9	U	4 6	U	5 9	U	5 2	U	6	U	[illegible]		11	U
Aroclor-1260	UG/KG	44	0 04762	0 02704	HHB	1	1	21	59	U	46	U	59	U	52	U	60	U	41	U	110	U
Endosulfan I	UG/KG	7 5	0 09524	1 014	BALC	2	2	21	3	U	2 4	U	3	U	2 6	U	3 1	U	2 1	U	5 7	U
Endosulfan sulfate	UG/KG	12	0 09524			0	2	21	5 9	U	4 6	U	5 9	U	6 1	U	6	U	4 1	U	11	U
Endrin ketone	UG/KG	9 4	0 04762			0	1	21	5 9	U	4 6	U	5 9	U	3 9	UJ	6	U	4 1	U	11	U
Metals																						
Aluminum	MG/KG	16700	1			0	21	21	12700		15200		9230		6320		7030		2600		12300	
Arsenic	MG/KG	6 8	1	6	LEL	1	21	21	3		5 6		3 2		3 8		3 1		2 5		[illegible]	
Barium	MG/KG	107	1			0	21	21	57 7		94 4		63 9		34 7	J	48 8		26 8		105	J
Beryllium	MG/KG	0 8	1			0	21	21	0 48		0 6		0 3		0 29	J	0 25		0 08		0 47	J
Cadmium	MG/KG	0 83	0 19048	0 6	LEL	2	4	21	0 09	U	0 06	U	0 1	U	0,09	U	0 06	U	0 06	U	0 19	U
Calcium	MG/KG	211000	1			0	21	21	3750		19600		69000		90000		47400		211000		55600	
Chromium	MG/KG	24 4	1	26	LEL	0	21	21	19 2		24 4		17 3		12		12 4		7 9		22 4	
Cobalt	MG/KG	14 4	1			0	21	21	7		13 3		11 2		7 5	J	8 2		2 7		14 4	J
Copper	MG/KG	42 6	1	16	LEL	18	21	21	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		7 4		[illegible]	
Cyanide	MG/KG	2 1	0 04762			0	1	21	1	UJ	0 8	UJ	0 89	UJ	0 78	UJ	0 99	UJ	0 63	UJ	1 7	UJ
Iron	MG/KG	29700	1	20000	LEL	8	21	21	20000		[illegible]		19800		12600		12700		6360		[illegible]	
Lead	MG/KG	46 2	0 80952	31	LEL	5	17	21	18		16 7		[illegible]		19 6	J	24 9		3 4		[illegible]	J
Magnesium	MG/KG	16100	1			0	21	21	3820		7140		12300		9640		7590		16100		14800	
Manganese	MG/KG	995	1	460	LEL	9	21	21	217	J	[illegible]	J	[illegible]	J	315		[illegible]	J	315		[illegible]	
Mercury	MG/KG	0 12	0 2381	0 15	LEL	0	5	21	0 07	U	0 06	U	0 07	U	0 06	UJ	0 09	U	0 05	U	0 18	UJ
Nickel	MG/KG	44 2	1	16	LEL	19	21	21	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		4 5		[illegible]	
Potassium	MG/KG	2570	1			0	21	21	1380		1840		1180		1360	J	1160		509		2350	J
Selenium	MG/KG	2 1	0 28571			0	6	21	1 4		1	U	1 7		1 4	U	1 3		0 94	U	3	U
Sodium	MG/KG	578	0 80952			0	17	21	172	U	130	U	202	U	312	J	343		122	U	578	J
Thallium	MG/KG	2 3	0 14286			0	3	21	1 8	U	1 7		2 1	U	1 8	UJ	1 7	U	1 3	U	4	UJ
Vanadium	MG/KG	28	1			0	21	21	20 9		24		20 8		15 5		15 8		11 7		26 9	J
Zinc	MG/KG	534	1	120	LEL	5	21	21	60 4		72 1		118		120	J	87 4		24 7		[illegible]	J

Notes
(1) BALC = Benthic Aquatic Life Chronic HHB = Human Health Bioaccumulation LEL = Lowest Effect Level

Table 2-11
ESI and Phase I RI Data Sediment
SEAD-63 EE/CA
Seneca Army Depot Activity

Parameter	Unit	aximum oncentration	requency of etection (%)	omparison evel (1)	omparison Level ype (1)	umber of Times alue Exceeds omparison Level	umber of Times etected	umber of amples	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q	Value	Q
Area									SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD 63	
Loc_Id									WSD63-16		SWSD63 19		SWSD63-11		SWSD63-6		SWSD63-7		SWSD63-7	
Matrix									SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
Samp_Id									63106		63109		63102		63104		12215		63101	
Sample Depth									0 4		0 4		0 5		0 5		0 7		0 7	
Sample Depth									0 6		0 6		0 7		0 7		0 9		0 9	
Sample Date									12/11/97		12/11/97		12/5/97		12/11/97		12/4/97		12/4/97	
Sample Type									SA		SA		SA		SA		DU		SA	
Study Id									P1S1		P1S1		P1S1		P1S1		P1S1		P1S1	
Volatile Organic Compounds																				
Acetone	UG/KG	150	0 42857			0	9	21	21	UJ	9	J	14	U	20	UJ	18	J	16	UJ
Methyl ethyl ketone	UG/KG	35	0 09524			0	2	21	21	UJ	18	U	14	UJ	20	UJ	18	UJ	16	UJ
Toluene	UG/KG	14	0 04762	1656	BALC	0	1	21	21	U	18	U	14	U	20	U	18	U	16	U
Semi-Volatile Organic Compounds																				
2-Methylnaphthalene	UG/KG	14	0 09524	1149	BALC	0	2	21	100	U	14	J	88	U	150	U	120	U	120	U
Acenaphthene	UG/KG	80	0 14286	4732	BALC	0	3	21	100	U	80	J	88	U	150	U	120	U	120	U
Acenaphthylene	UG/KG	82	0 14286			0	3	21	100	U	82	J	88	U	150	U	120	U	120	U
Anthracene	UG/KG	250	0 42857	3617	BALC	0	9	21	100	U	250		7 3	J	150	U	120	U	120	U
Benzo(a)anthracene	UG/KG	1600	0 95238	44	HHB	2	20	21	8 1	J	[illegible]	J	[illegible]	J	12	J	14	J	13	J
Benzo(a)pyrene	UG/KG	2900	0 95238	44	HHB	13	20	21	10	J	[illegible]	J	[illegible]	J	15	J	23	J	21	J
Benzo(b)fluoranthene	UG/KG	5300	0 95238	44	HHB	14	20	21	15	J	[illegible]	J	[illegible]	J	33	J	39	J	37	J
Benzo(ghi)perylene	UG/KG	2700	0 95238			0	20	21	12	J	2700	J	44	J	11	J	12	J	12	J
Benzo(k)fluoranthene	UG/KG	570	0 66667	44	HHB	10	14	21	9 9	J	770	UJ	88	U	150	U	120	U	120	U
Bis(2-Ethylhexyl)phthalate	UG/KG	110	0 52381	8743	BALC	0	11	21	8 3	J	20	J	110	J	9 8	J	21	J	25	J
Butylbenzylphthalate	UG/KG	22	0 2381			0	5	21	100	U	150	U	88	U	150	U	19	J	22	J
Carbazole	UG/KG	430	0 47619			0	10	21	100	UJ	430	J	9 4	J	150	UJ	120	UJ	120	UJ
Chrysene	UG/KG	2300	0 95238	44	HHB	13	20	21	12	J	2300	J	72	J	15	J	14	J	13	J
Di-n-butylphthalate	UG/KG	19	0 47619			0	10	21	6 5	J	150	U	18	J	150	U	19	J	14	J
Di-n-octylphthalate	UG/KG	19	0 04762			0	1	21	100	U	150	U	88	U	150	U	120	U	120	U
Dibenz(a,h)anthracene	UG/KG	1200	0 52381			0	11	21	100	U	1200		19	J	150	U	8 7	J	120	U
Dibenzofuran	UG/KG	36	0 09524			0	2	21	100	U	35	J	88	U	150	U	120	U	120	U
Diethyl phthalate	UG/KG	92	0 33333			0	7	21	100	U	150	U	88	U	150	U	7 4	J	120	U
Fluoranthene	UG/KG	4100	0 95238	34476	BALC	0	20	21	18	J	4100	J	100		28	J	32	J	32	J
Fluorene	UG/KG	110	0 14286	270	BALC	0	3	21	100	U	110	J	88	U	150	U	120	U	120	U
Indeno(1,2,3-cd)pyrene	UG/KG	2500	0 95238	44	HHB	10	20	21	8 2	J	2500	J	37	J	11	J	14	J	12	J
Naphthalene	UG/KG	23	0 09524	1014	BALC	0	2	21	100	U	23	J	88	U	150	U	120	U	120	U
Phenanthrene	UG/KG	1400	1	4056	BALC	0	21	21	6	J	1400	J	51	J	12	J	16	J	14	J
Phenol	UG/KG	11	0 04762	17	BALC	0	1	21	100	U	150	U	88	U	150	U	120	U	120	U
Pyrene	UG/KG	3200	0 95238	32482	BALC	0	20	21	14	J	3200	J	80	J	19	J	23	J	23	J
Pesticides																				
4,4'-DDD	UG/KG	3 9	0 04762	0 338	HHB	1	1	21	5	U	7 7	U	4 4	U	7 3	U	6 1	U	6 2	U
4,4'-DDE	UG/KG	9 2	0 14286	0 338	HHB	3	3	21	5	U	7 7	U	4 4	U	7 3	U	6 1	U	6 2	U
4,4'-DDT	UG/KG	8 3	0 09524	0 338	HHB	2	2	21	5	U	12	U	4 4	U	7 3	U	6 1	U	6 2	U
Aroclor-1260	UG/KG	44	0 04762	0 02704	HHB	1	1	21	50	U	77	U	44	U	73	U	44	J	62	U
Endosulfan I	UG/KG	7 5	0 09524	1 014	BALC	2	2	21	2 6	U	4	U	2 3	U	3 8	U	3 1	U	3 2	U
Endosulfan sulfate	UG/KG	12	0 09524			0	2	21	5	U	12		4 4	U	7 3	U	6 1	U	6 2	U
Endrin ketone	UG/KG	9 4	0 04762			0	1	21	5	U	12	U	4 4	U	7 3	U	6 1	U	6 2	U
Metals																				
Aluminum	MG/KG	16700	1			0	21	21	12800		11000		2030		11900		16700		9770	
Arsenic	MG/KG	6 8	1	6	LEL	1	21	21	5 2		5 7		2 3	J	4 1	J	5 2		2 9	
Barium	MG/KG	107	1			0	21	21	64		81 3	J	19 9	J	76 2	J	107		68 1	
Beryllium	MG/KG	0 8	1			0	21	21	0 59	J	0 28	J	0 11	J	0 63	J	0 8	J	0 51	J
Cadmium	MG/KG	0 63	0 19048	0 6	LEL	2	4	21	0 08	U	0 13	U	0 08	U	0 13	U	0 08	U	0 08	U
Calcium	MG/KG	211000	1			0	21	21	14400		43300		139000		2650		3060		2090	
Chromium	MG/KG	24 4	1	26	LEL	0	21	21	21 8		18 8		4 1		18 5		23 4		15	
Cobalt	MG/KG	14 4	1			0	21	21	12 7	J	12	J	3 2	J	7 6	J	10 7	J	7 9	J
Copper	MG/KG	42 6	1	16	LEL	18	21	21	[illegible]		[illegible]		8 7		[illegible]		[illegible]		15 9	
Cyanide	MG/KG	2 1	0 04762			0	1	21	0 76	UJ	1 2	UJ	2 1	J	1 2	UJ	1 1	UJ	1 1	UJ
Iron	MG/KG	29700	1	20000	LEL	8	21	21	[illegible]		[illegible]		4790		18700		[illegible]		16300	
Lead	MG/KG	46 2	0 80952	31	LEL	5	17	21	20 8	J	[illegible]	J	8 6	J	23 2	J	28 3	J	17 6	J
Magnesium	MG/KG	18100	1			0	21	21	5400		9980		9380		3260		4090		2610	
Manganese	MG/KG	995	1	460	LEL	9	21	21	346		[illegible]		225		222		[illegible]		431	
Mercury	MG/KG	0 12	0 2381	0 15	LEL	0	5	21	0 08	UJ	0 1	UJ	0 05	UJ	0 11	UJ	0 07	UJ	0 08	J
Nickel	MG/KG	44 2	1	16	LEL	19	21	21	[illegible]		[illegible]		8 8	J	[illegible]		[illegible]		[illegible]	
Potassium	MG/KG	2570	1			0	21	21	1460		2000	J	597	J	1580	J	1830		1120	J
Selenium	MG/KG	2 1	0 28571			0	6	21	1 3	U	2 1	U	1 2	U	2	U	1 3	U	1 2	U
Sodium	MG/KG	578	0 80952			0	17	21	221	J	543	J	323	J	298	J	302	J	234	J
Thallium	MG/KG	2 3	0 14286			0	3	21	1 7	UJ	2 6	UJ	1 6	J	2 7	UJ	1 8	UJ	1 6	UJ
Vanadium	MG/KG	28	1			0	21	21	19 6		28		10 9	J	20 7	J	27 7		17 1	
Zinc	MG/KG	534	1	120	LEL	5	21	21	73 4	J	[illegible]	J	37 2	J	65 8	J	81	J	52.3	J

Notes
(1) BALC = B Life Chronic HHB = Human Health Bioaccumulation LEL = Lowest Effect Level

2.6.6.4 Metals

Twenty-two metals were detected in the sediment samples collected at SEAD-63. Arsenic, cadmium, copper, iron, lead, manganese, nickel, and zinc were detected at concentrations that exceeded their respective NYSDEC criteria values. Copper, manganese, nickel, and zinc were detected at concentrations at least twice, but not more than five times their respective criteria values. Copper was found in all but three samples above its criteria; nickel was found in all but two samples above its criteria. Manganese was found in nine samples where it exceeded its criteria and zinc was found in five samples above its criteria.

2.6.6.5 Radioactivity

Table 2-12 presents the summary of the radioactivity analysis results for the sediment samples collected at SEAD-63. The gamma and alpha spectral analyses of the sediment samples collected at SEAD-63 showed various levels of principal and associated radionuclides from three natural radioactive decay series including the thorium series, the uranium series and the actinium series. Principal radionuclides from these series that were detected include Pb-210, Ra-226, Ra-228, Th-228, U-233/234, U-235, and U-238. The presence of Ac-227 was inferred by the presence of Th-227. All of these radionuclides are naturally occurring. When associated radionuclides are present, the highest detected concentration of either associated radionuclide or principal radionuclide was assigned to the principal radionuclide. In addition, Cs-137 was detected in 11 samples. Cs-137 is a fission product and is present in the environment due to nuclear weapons testing fallout (Eisenbud and Gesell, 1997). Potassium-40, a naturally occurring radioisotope, was detected in the four samples collected during the ESI. Analysis for this isotope was not requested during the RI sampling event at SEAD-63.

Gross alpha and gross beta radiation was also detected in the four sediment samples collected at SEAD-63 during the ESI (this analysis was not performed on sediment during the RI field investigation).

No NYSDEC criteria exist for reported levels of radionuclides in sediment. However, background sediment samples were collected at SEDA during the RI field investigation and are used for comparison. Summary statistics for the background data and the SEAD-63 sediment data are presented in **Table 2-13** and were calculated as described for soil in **Section 2.6.3.5**.

Table 2-12
Sediment Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	LOC_ID	SD63-1			SD63-2			SD63-3			SD63-4			SWSD63-10			SWSD63-11			SWSD63-12		
	SAMP_ID													63112			63102			63105		
	TOP	0			0			0			0			0.3			0.5			0.6		
	BOTTOM	0.2			0.2			0.2			0.2			0.5			0.7			0.8		
	MATRIX	SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT		
	STUDY	ESI			ESI			ESI			ESI			Phase I RI			Phase I RI			Phase I RI		
PARAM	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/g		NR			NR			NR			NR		0.1		0.1	0.8	U	0.1	0.6	U	0.1
Cesium-137	pCi/g	0.68		0.07	0.95		0.09	0.13		0.04	1.5		0.1	0.2	UJ		0.4	UJ		0.8	U	
Cobalt-57	pCi/g		NR			NR			NR			NR		0.1	U		0.1	U		0.1	U	
Cobalt-60	pCi/g		NR			NR			NR			NR		0.2	U		0.1	U		0.3	U	
Lead-210	pCi/g	4.1		0.8	3.2		0.7	2.8		0.7	3.2		0.7	5.1	U	•	16.2	U		20.7	U	
Plutonium-239/240	pCi/g		NA			NA			NA			NA		0.3	UJ	0.1	0.1	UJ	0.2	0.2	UJ	0.2
Radium-223	pCi/g		NR			NR			NR			NR		0.3	U		0.2	U		0.5	U	
Radium-226	pCi/g	1.1		0.3	0.93		0.34	0.98		0.96	1.4		0.4	1		0.3	0.9	UJ		1.5		0.4
Radium-228	pCi/g	0.65		0.23	0.68		0.23	0.97		0.4	1		0.3	1.5	UJ		0.9	J	0.3	1.9		0.5
Thorium-228	pCi/g	1		0.5	0.8		0.53	1.2		0.4	1.3		0.6	NR			NR			NR		
Thorium-230	pCi/g		NA			NA			NA			NA		1.3	J	0.7	1.4	J	0.6	1.9	UJ	1
Thorium-232	pCi/g		NA			NA			NA			NA		0.6	J	0.3	0.4	J	0.3	0.8	J	0.6
Tritium	pCi/g		NA			NA			NA			NA		0.1	UJ	0.1	0.1	UJ	0.1	0.1	U	0.1
Uranium-233/234	pCi/g		NR			NR			NR			NR		0.7		0.3	0.8		0.3	1.3		0.4
Uranium-235	pCi/g	0.06		0.06	0.06		0.21	0.02		0.16	0.04		0.22	0.1	U	0.1	0.1	U	0.1	0.3	U	0.2
Uranium-238	pCi/g	0.5		0.32	0.24		0.24	0.6		0.37	0.36		0.12	0.6	U	0.2	0.6	UJ	0.2	1.4		0.5
Gross Alpha	pCi/g	11		6	13		5	14		5	13		6		NA			NA			NA	
Gross Beta	pCi/g	24		6	29		6	36		6	33		6		NA			NA			NA	
Moisture (@ 104 deg C)	% by Wt		NA			NA			NA			NA		17.6			15.8			26.9		

Notes: Detected Principal Radionuclides only shown.
No sediment criteria are available for these radionuclides.
ND - Not detected, NR - Not reported

Table 2-12
Sediment Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	LOC_ID	SWSD63-13			SWSD63-14			SWSD63-14			SWSD63-15			SWSD63-16			SWSD63-17			SWSD63-18			SWSD63-19		
	SAMP_ID	63116			12217			63111			63113			63106			63107			63108			63109		
	TOP	0.2			0.3			0.3			0.2			0.4			0.3			0.2			0.4		
	BOTTOM	0.4			0.5			0.5			0.4			0.6			0.6			0.4			0.6		
	MATRIX	SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT		
	STUDY	Phase I RI			Phase I RI - DU			Phase I RI			Phase I RI			Phase I RI			Phase I RI			Phase I RI			Phase I RI		
PARAM	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/g	0.7	UJ	0.1	0.1	U	0.2	0.1	U	0.1	0.2	UJ	0.3	0.3		0.3	0.1	UJ	0.4	0.1	U	0.3	0.8	UJ	. 0.1
Cesium-137	pCi/g	0.3	U		1.4	J	0.2	1.5	J	0.3	1	J	0.2	0.7	U		1.1	UJ		1.2	UJ		2.1	UJ	
Cobalt-57	pCi/g	0.1	U		0.1	U		0.1	U		0.1	U		0.1	U		0.1	UJ		0.1	U		0.1	UJ	
Cobalt-60	pCi/g	0.3	U		0.1	U		0.1	U		0.2	U		0.1	U		0.1	UJ		0.1	U		0.3	UJ	
Lead-210	pCi/g	34.7	U		23.5	U		4.1	U		30.2	U		4.8	U		9.1	J	3.7	12	U		7.7	UJ	
Plutonium-239/240	pCi/g	0.8	UJ	0.1	0.2	U	0.2	0.1	U	0.1	0.3	U	0.1	0.2	UJ	0.2	0.1	UJ	0.1	0.1	U	0.1	0.1	UJ	0.2
Radium-223	pCi/g	0.5	U		0.5	U		0.6	U		1.4	U		0.5	U		0.5	UJ		0.4	U		0.8	UJ	
Radium-226	pCi/g	1.5	UJ		1.9		0.4	2.3	·	0.5	2.1	U		1.8		0.5	2.1	J	0.7	1.7	U		2.3	J	0.4
Radium-228	pCi/g	1.9	J	0.6	1.1	UJ		2.5	J	0.7	2.1	J	0.6	2.8		0.8	2.5	UJ		1.4	J	0.5	2.3	J	0.6
Thorium-228	pCi/g	NR			NR			NR			NR			NR			NR			NR			NR		
Thorium-230	pCi/g	1	UJ	0.6	1.2	J	0.5	1.5	J	0.6	1.2	J	0.7	2.1	UJ	0.9	2	J	1.2	0.6	J	0.6	1	J	1
Thorium-232	pCi/g	1.1	J	0.5	1.1	J	0.4	1	J	0.5	1.2	J	0.6	0.9	J	0.6	1.8	J	1	1.4	J	0.6	1.2	J	0.6
Tritium	pCi/g	0.1	UJ	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	U	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	UJ	0.1
Uranium-233/234	pCi/g	0.8		0.3	0.9		0.3	1.1		0.4	0.6		0.3	0.7		0.3	0.8	J	0.3	0.8		0.3	0.6	UJ	0.3
Uranium-235	pCi/g	0.1	U	0.1	0.2	U	0.1	0.1	U	0.1	0.1	U	0.1	0.1	U	0.1	0.1	UJ	0.1	0.1	U	0.1	0.1	UJ	0.1
Uranium-238	pCi/g	0.7		0.3	0.9		0.3	0.9		0.3	0.6	U	0.2	0.9		0.3	0.9	UJ	0.3	0.8		0.3	0.6	UJ	0.3
Gross Alpha	pCi/g		NA			NA			NA			NA			NA			NA			NA			NA	
Gross Beta	pCi/g		NA			NA			NA			NA			NA			NA			NA			NA	
Moisture (@ 104 deg C)	% by Wt	25			39.7			41.8			41.7			21.3			57.4			37			50.4		

Table 2-12
Sediment Radionuclide Data
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

	LOC_ID	SWSD63-20			SWSD63-5			SWSD63 6			SWSD63-7			SWSD63-7			SWSD63-8			SWSD63-9		
	SAMP_ID	63110			63115			63104			12215			63101			63114			63103		
	TOP	0.3			0.2			0.5			0.7			0.7			0.2			0.2		
	BOTTOM	0.5			0.4			0.7			0.9			0.9			0.4			0.4		
	MATRIX	SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT			SEDIMENT		
	STUDY	Phase I RI			Phase I RI			Phase I RI			Phase I RI - DU			Phase I RI			Phase I RI			Phase I RI		
PARAM	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/g	0.5	U	0.1	0.2	U	0.3	0.3		0.4	0.1	U	0.2	0.4	UJ	0.1		ND		1.0		1.0
Cesium-137	pCi/g	0.8	J	0.3	1.1	U		0.6		0.3	0.9	J	0.2	0.8	UJ		1.3	U		0.9		0.2
Cobalt-57	pCi/g	0.1	U		0.1	U		0.1	U		0.1	U		0.1	U		0.1	U		0.1	U	
Cobalt-60	pCi/g	0.1	U		0.4	U		0.2	U					0.3	U		0.1	U		0.4	U	
Lead-210	pCi/g	4.7	U		4.9		1.5	3.3	U		26.7	U		5.6	U		29.1	U		28.3	U	
Plutonium-239/240	pCi/g	0.2	UJ	0.2	0.3	U	0.2	0.1	UJ	0.2	0.3	UJ	0.1	0.2	U	0.1	0.3	UJ	0.2	0.4	UJ	0.1
Radium-223	pCi/g	0.5	U		0.6	U		0.4	U		0.5	U		0.7	U		0.4	U		0.4	U	
Radium-226	pCi/g	1.6		0.5	2.2	J	0.6	3.3		0.9	1.4	J	0.3	2	J	0.5	1.6	J	0.3	1.9	U	
Radium-228	pCi/g	2		0.8	2.3	J	0.6	3		0.7	2.4	J	0.5	2.5	J	0.6	2	J	0.5	2		0.5
Thorium-228	pCi/g	NR			NR			NR			NR			NR			NR			NR		
Thorium-230	pCi/g	1.7	J	0.7	1.5	UJ	0.6	3	UJ	1.2	1.2	J	0.6	1.6	J	0.7	2	UJ	1.1	2.2		1.8
Thorium-232	pCi/g	0.8	J	0.4	1.2	J	0.6	0.9	J	0.6	1	J	0.5	1.4	J	0.6	1.9	J	1.1	0.9		0.9
Tritium	pCi/g	0.1	UJ	0.1	0.1	UJ	0.1	0.1	U	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	U	0.1
Uranium-233/234	pCi/g	0.7		0.3	0.9		0.4	0.8		0.4	1		0.4	0.8		0.3	0.9	J	0.4	1	J	0.4
Uranium-235	pCi/g	0.1	U	0.1	0.2	U	0.1	0.1	U	0.1	0.1	U	0.1	0.1	U	0.1	0.2	UJ	0.2	0.2	UJ	0.2
Uranium-238	pCi/g	0.8		0.3	0.8	U	0.3	0.8	U	0.3	0.8	UJ	0.3	1.1	J	0.4	0.7	UJ	0.3	1	J	0.4
Gross Alpha	pCi/g		NA			NA			NA			NA			NA			NA			NA	
Gross Beta	pCi/g		NA			NA			NA			NA			NA			NA			NA	
Moisture (@ 104 deg. C)	% by Wt	33.1			38.4			30.9			48.4			46.6			31.3			31.3		

Table 2-13
Comparison of Summary Statistics in Background Sediment to SEAD-63 Sediment for Radionuclides
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

Parameter	Units	No. of Samples		No. of Hits		Frequency		Minimum		Maximum Detected Values		Average		Median		Std Dev		Wilcoxen Mean Rank		Zrs	Z(1-alpha)	Reject Null Hypothesis?
		BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63	BKGD	SEAD-63			
Actinium-227 (1)	pCi/g	8	17	5	4	63%	24%	0 05	0.05	0 40	1 00	0 25	0 24	0 15	0 20	0.23	0 24					
Cobalt-57	pCi/g	9	18	0	0	0%	0%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Cobalt-60	pCi/g	9	18	0	0	0%	0%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Cesium-137	pCi/g	9	22	1	11	11%	50%	0 05	0.10	0.60	1 50	0 22	0 70	0 20	0 63	0.16	0.42					
Tritium	pCi/g	9	18	2	0	22%	0%	0 05	ND	0 20	ND	0 08	ND	0.05	ND	0.05	ND					
Lead-210	pCi/g	9	22	0	6	0%	27%	ND	1.65	ND	9 10	ND	7 05	ND	4 50	ND	5.18					
Plutonium-239/240	pCi/g	9	18	2	0	22%	0%	0.05	ND	0.20	ND	0.11	ND	0.10	ND	0.05	ND					
Radium-226	pCi/g	9	22	6	17	67%	77%	0 70	0.45	2.00	3 30	1 36	1.53	1.30	1 45	0.48	0 67	14 61	16.57	0 5449	1 645	No
Thorium-230	pCi/g	9	18	3	12	33%	67%	0 35	0 50	1.40	2 20	0 86	1 26	0 60	1 20	0 34	0 45					
Thorium-232	pCi/g	9	18	9	18	100%	100%	0 80	0.40	1.90	1 90	1 29	1 09	1 30	1 05	0.36	0 39	16 76	12.61	-1.2938	1 645	No
Uranium-233/234	pCi/g	9	18	3	17	33%	94%	0 25	0 40	0 90	1 30	0 51	0 84	0 45	0 80	0 24	0 20					
Uranium-235	pCi/g	9	20	3	4	33%	20%	0 05	0 05	0 20	0 06	0 13	0 07	0.10	0 05	0.09	0.03					
Uranium-238	pCi/g	9	22	1	13	11%	59%	0 20	0 24	0 80	1 40	0 34	0 60	0 30	0 48	0 18	0 33					
Radium-228	pCi/g	9	22	8	19	89%	86%	1 20	0 55	2 40	3 00	1 81	1 73	1 90	1 95	0 43	0.77	16 39	15 84	-0 1528	1 645	No
Promethium 147	pCi/g	9	NA	8	NA	89%	NA	1 85	NA	16.30	NA	11 39	NA	12 00	NA	4 59	NA					

(1) Actinium 227 is the principal radionuclide of Th-227. The value reported for Th-227 was assigned to Ac-227

NA - Not analyzed

NR - Not reported in Gamma Spectral Analysis conducted during ESI.

ND - Not detected

Note When sample was reported as ND, one half the detection limit was assigned to the sample for the purposes of calculating statistics, except for the maximum value, which only considered detected values

Note WRS test only performed on radionuclides where less than 40% of data were non-detects

This table includes the Wilcoxon Mean Rank for each data set. The complete background data set is provided in **Appendix D**.

All radionuclides detected at SEAD-63, except for one, Pb-210, were detected in background samples collected. Lead-210 is a decay product of Ra-226, which was detected in background samples. The maximum value of each radionuclide detected in the sediment at SEAD-63, was greater than the maximum value of detected in background sediment except for Th-232, U-235 and Pu-239/240. Average values of Cs-137, Ra-226, Th-230, U-233/234, and U-238 at SEAD-63 were above average background levels. However, the results of the Wilcoxon Rank Sum test, conducted as described in **Section 2.6.3.5**, indicated that Ra-226 was not elevated above the background data set. All of these radioisotopes except for Cs-137 are naturally occurring and Cs-137 is present in the environment due to nuclear weapons testing fallout (Eisenbud and Gesell, 1997).

Because no NYSDEC criteria exist for radionuclides in sediment, clean up guidelines for soil were used to determine if the radionuclides distinguishable from background at SEAD-63 are potentially of concern. Although exposure to sediment can differ from surface soil exposure, under the likely exposure scenarios at SEAD-63, exposure to either media would be similar, incorporating the following pathways: direct exposure, ingestion and dermal contact. According to NYSDEC TAGM Memorandum 4003, the total effective dose equivalent to the maximally exposed individual of the general public, from radioactivity material remaining at the site after cleanup, shall be as low as reasonably achievable and less than 10 mrem above that received from background levels of radiation in any one year.

In order to compare the site sediment data to the 10 mrem/yr TAGM, a dose equivalent was established using RESRAD. This model uses dose assessment methodology recommended for use in deriving site-specific soil guidelines. In addition, RESRAD calculates a dose equivalent using site specific information (such as geometry of the site, radionuclide activities, and site hydrology). RESRAD's applicability is to soil, however, due to the similar exposure pathways, it is being used to determine if sediment is a media of concern with respect to radionuclides. Radionuclides distinguishable from background in sediment were input into RESRAD to determine the dose equivalent above background for four different exposure scenarios. Maximum values detected were considered to be conservative. Radionuclides considered included Cs-137, Th-230, U-233/234, and U-238. Lead-210 was also considered since it was not detected in background, but was in the site data. A recreational child, a park worker, and construction worker scenario were selected as the most likely exposure scenarios under the future use plans for SEAD-63.

Table 2-14 shows the results of the RESRAD runs for the three scenarios. Site specific inputs and RESRAD output files are provided in **Appendix E**. The highest dose equivalent is generated under the construction worker scenario due primarily to the ingestion of Pb-210. Even though the maximum values of each radionuclide distinguishable from background were used and background contribution of these radionuclides were not considered, the dose equivalents for each scenario are below the 10mrem/yr NYSDEC TAGM value. Therefore, sediment is not considered a media of concern with respect to radionuclides.

2.6.7 Contamination Assessment Summary

The results of the ESI and RI field work conducted at SEAD-63 indicate that past activities on site have had some impact on the soil quality. It is also possible that past activities on site may have impacted the groundwater and surface water quality, though the elevated chemical and radiogenic results in the groundwater samples may be due solely to the high turbidity levels of those samples.

Miscellaneous military debris was found in several test pits on site. The extent of the former disposal pits on site were confirmed by geophysical surveys and the test pits conducted. The chemical and radiological impact on environmental media due to past activities on site is summarized below.

Soil

The soil analysis results indicate that soils are impacted by cadmium in several areas that were investigated by test pits during the ESI at SEAD-63. Cadmium concentrations in three test pit samples exceeded the TAGM value of 2.4 mg/kg by up to an order of magnitude. Mercury was detected in one test pit sample (TP63-3) at a concentration of 0.49 mg/kg, exceeding the TAGM value of 0.1 mg/kg. The average concentrations of both cadmium and mercury in SEAD-63 soils exceeded twice the average background concentration.

Table 2-14
RESRAD Dose Equivalents for Sediment Exposure
Seneca Army Depot Activity, Romulus, NY

					RESRAD Output (3)			
Parameter (1)	**Units**	**Maximum Values Detected in Sediment (pCi/g)**		**RESRAD Input (2) (pCi/g)**	**Residential Dose Equivalent mrem/yr**	**Construction Worker Dose Equivalent mrem/yr**	**Recreational Child Dose Equivalent mrem/yr**	**Park Worker Dose Equivalent mrem/yr**
		BKGD	**SEAD-63**					
Cesium-137	pCi/g	0.60	1.50	1.50	2.969	2.329	1.632	1.88
Lead-210	pCi/g	ND	9.10	9.10	1.857	4.045	7.95E-02	6.05E-01
Thorium-230	pCi/g	1.40	2.20	2.20	7.65E-02	2.42E-01	2.49E-03	2.82E-02
Uranium-233/234	pCi/g	0.90	1.30	1.30	2.04E-02	6.27E-02	6.34E-04	7.39E-03
Uranium-238	pCi/g	0.80	1.40	1.40	1.32E-01	1.49E-01	6.20E-02	7.80E-02
TOTAL DOSE EQUIVALENT (TAGM = 10mrem/yr above background):					**5.055**	**6.828**	**1.777**	**2.854**

(1) Only radionuclides distinguishable from background and those present in SEAD-63 sediment, but not present in background sediment were considered.

(2) The average value or one-third the maximum value above background is recommended for input into RESRAD. However, the maximum value was used as a conservative input. Other RESRAD inputs are provided in Appendix E.

(3) RESRAD Output is provided in Appendix E. Reported dose equivalents are for t=0 years.

Based on a statistical comparison of radionuclide data from SEAD-63 and from background, the level of radionuclides from SEAD-63 are not distinguishable from background. Therefore, the soils at SEAD-63 do not exhibit a dose equivalent above the NYSDEC TAGM (10 mrem/yr above background).

Volatile organic compounds, semivolatile organic compounds, and pesticides were detected at low concentrations and only one semivolatile compound, dibenz(a,h)anthracene, was found at a concentration that exceeded its associated TAGM value. Dibenz(a,h)anthracene exceeded its TAGM value by 2 in one soil sample from TP63-9.

Groundwater

Radioactivity analysis results indicate that the groundwater in MW63-3 (located hydraulically downgradient of the disposal pits) may be impacted by gross alpha and gross beta radiation. The level of gross alpha radiation in this well was an order of magnitude above the NYS AWQS Class GA and federal drinking water criteria. In addition, gross alpha levels exceeded the NYS AWQS in MW63-1, which is considered to be the background location for the purpose of the ESI). Gross beta radiation levels detected in the groundwater samples collected from groundwater monitoring wells MW63-3 and MW63-1 may be similarly impacted, though the elevated gross beta levels may be due to the high NTUs of those groundwater samples. The NYS AWQS for gross beta was not exceeded.

Other constituents that were detected include one semivolatile organic compound and metals. Phenol was detected at a concentration of 2J mg/L, exceeding its criteria value of 1 mg/L. Iron and manganese were detected above their criteria in all of the groundwater samples collected at SEAD-63.

Surface Water

Surface water at SEAD-63 has been impacted by SVOCs (primarily phthalates). Two SVOCs were detected at levels exceeding the NYS AWQS. In addition, aluminum, cobalt, iron, lead and silver were detected above their respective NYS AWQS.

Radionuclides present in background surface water locations were detected in the surface waters at SEAD-63. In addition, Co-60, Ra-226, Th-230, and U-233/234 were also detected at SEAD-63. The maximum and average values of the radionuclides detected at SEAD-63 were greater than the maximum and average background concentrations. Gross alpha and gross beta levels were significantly greater at SEAD-63 in at least one surface water location (SW63-2) than at background locations. However, the elevated levels at SW63-2 may be due to the high turbidity of this sample. Statistical comparison of the SEAD-63 and background data sets indicate that Ac-227, Radon 222, tritium, U-235, and U-238 are elevated above background. There are no NYS Ambient Water Quality Standards for radionuclides in Class C surface waters.

Sediment

Sediment at the site has been impacted by semivolatile organic compounds (mostly PAHs) and pesticides. The PAHs benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene, and indeno(1.2,3-cd) pyrene were detected at concentrations which exceeded the NYSDEC criteria value of 1.3 mg/kg by 2 to 3 times. No pesticides/PCBs were detected at levels greater than NYSDEC sediment criteria. Copper, manganese, nickel, and zinc were detected at concentrations at least twice their respective criteria values.

All radionuclides detected at SEAD-63, except for Pb-210, were also found in background sediment samples collected. Although the maximum values detected in the SEAD-63 samples exceeded the maximum values of the background samples, average values were comparable. Wilcoxon rank sum tests indicated that Cs-137, Th-230, U-233/234 and U-238 were elevated above background levels. No NYSDEC sediment criteria exist for these radionuclides. However, in comparison to the NYSDEC TAGM Cleanup Guideline for Soils Contaminated with Radioactive Material, radionuclides distinguishable from background in the sediment do not exhibit a dose equivalent greater than the 10 mrem/yr cleanup guideline based on RESRAD modeling.

2.8 STREAMLINED RISK EVALUATION

EPA guidance allows for the comparison of ARARs or risk-based values to conduct the streamlined risk evaluation for a non-time-critical removal action (EPA, 1993). The methods used to conduct streamlined risk evaluations, or mini-risk assessments, for sites at SEDA are the same as those used in prior baseline risk assessments at several of the other sites with the exception that the maximum concentration of a component will be used instead of the Upper 95th Confidence Limit (UCL) of the mean. The reason for using the maximum concentration is that at many of the sites, the existing database is small. Using the maximum detected value will provide an added degree of conservatism. Biased sampling has been performed, and the data represent "worst case" conditions.

ARAR and guideline comparisons were conducted in **Section 2.6** and summarized in **Tables 2-3 through 2-14** as well as in the discussion above in **Section 2.7**. In each of the four media investigated, one or more compounds exceed the criteria for that media. Cadmium exceeds its TAGM value at three locations and mercury and dibenz(a,h) anthracene exceed their TAGMs at one location in the soils at SEAD-63. The New York State AWQS for gross alpha in Class GA groundwater was exceeded in two groundwater samples. However, the elevated levels may be due to high turbidity samples or from upgradient activities. Surface water standards were exceeded for two SVOCs and several metals. In addition, five radionuclides were found to be statistically distinguishable from background levels of the same radionuclide. No surface water criteria exist for these radionuclides. In sediment, several PAHs exceeded the NYSDEC sediment criteria by 2 to 3 times and several metals exceeded their criteria by 2 to 5 times. Four radionuclides were considered to be elevated in relation to background sediment radionuclide levels. No sediment criteria exist for the radionuclides.

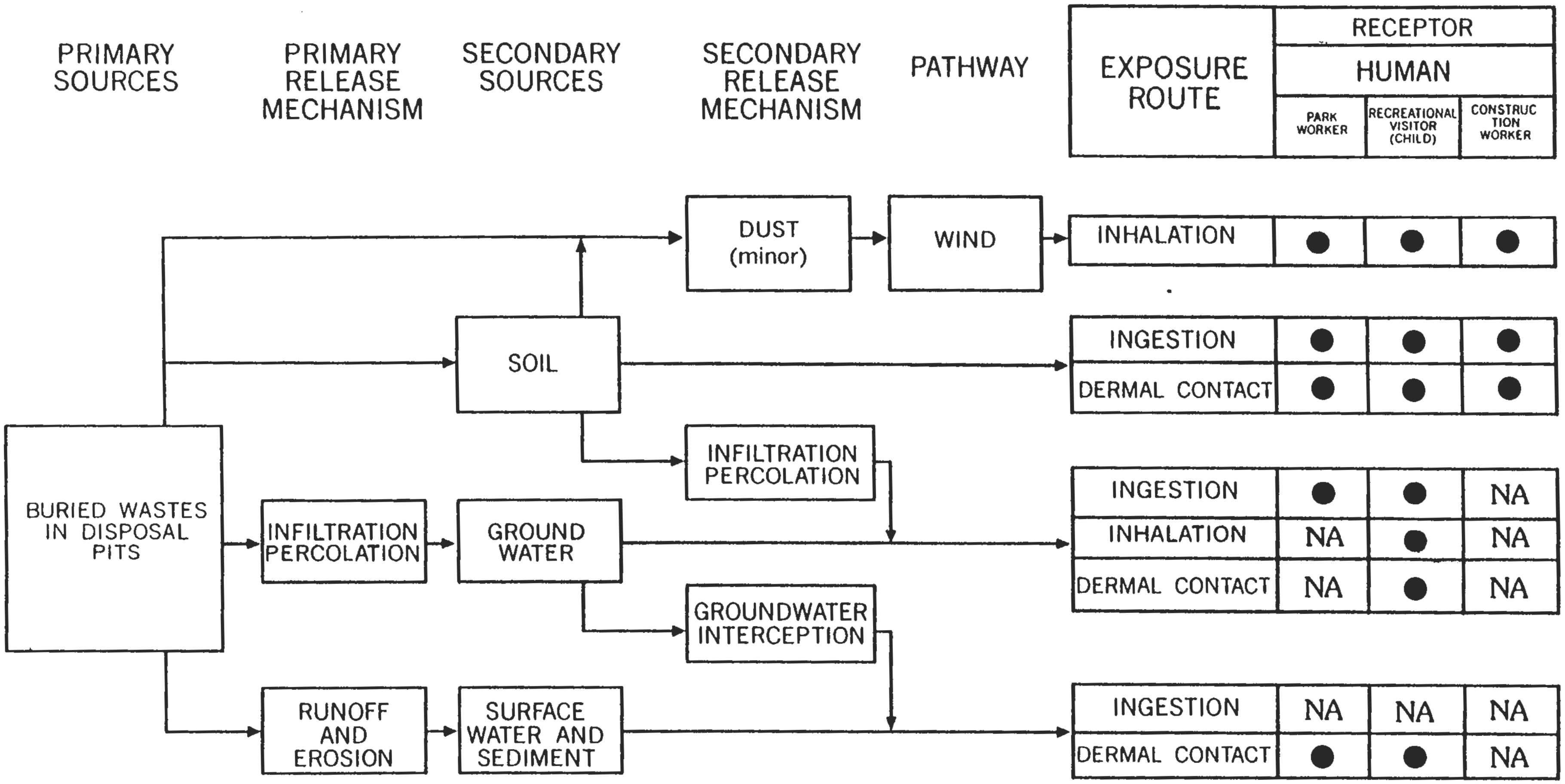
The exceedences of ARARs and guideline criteria summarized above are a preliminary indication that there is a possible threat to human health and the environment through several mechanisms at SEAD-63. The primary source areas identified during the ESI and the Project Scoping Plan for Performing a CERCLA RI/FS at SEAD-12 and SEAD-63 (Parsons ES, 1998) are disposal trenches in the central and northern portions of SEAD-63. The primary release mechanisms from the buried wastes and soils that comprise the disposal pits are infiltration and percolation of precipitation, surface water runoff and erosion. Groundwater, surface water, sediment, and soils surrounding the disposal pits are secondary sources. Groundwater interception to surface water and uptake of potential chemicals of concern by biota are secondary release mechanisms. Wind is also a secondary release mechanism from impacted soil.

SEDA has been placed on the 1995 Base Realignment and Closure List (BRAC List). The President and the Congress have approved the list and it has become public law. As BRAC applies to SEDA, future use of the sites will be determined by the Army. At the time this EE/CA was prepared, the Local Redevelopment Authority (LRA) had been given sole discretion in determining the future uses of the SEDA facility. The LRA has established that the Q Area, which includes SEAD-63, will be used as a Wildlife Conservation Area. At the time when the SEDA facility is relinquished by the Army, the Army will ensure that SEAD-63 can be used for the intended purpose.

The complete potential exposure pathways from sources to receptors, based upon current and future use scenarios, are shown in **Figure 2-12**. The potential for human exposures, with the exception of fugitive dust and radon gas, is directly affected by the accessibility to the site. Human and vehicular access to the site is restricted by a chain-link fence with a locking gate, which is part of SEDA's general security provisions.

Three scenarios shown in **Figure 2-12** were considered in conducting the mini-risk assessment for SEAD-63, the recreational child, park worker, and the construction worker. Only chemical constituents of concern were considered in the mini-risk assessment, since radionuclides were not present in soils above background levels and those present above background levels in sediments did not exhibit a dose equivalent of 10 mrem/yr above background. Risk assessment was conducted for residential receptors for comparative purposes only. Future residential use of the site is highly unlikely. In addition to the human health risk assessment, a mini-risk assessment was conducted for ecological risk. Four receptors were considered: the deer mouse, American robin, mourning dove, and short-tailed shrew. **Appendix F** provides the detailed assumptions and methodology used in conducting the mini-risk assessment.

Table 2-15 shows the human health risk associated with the exposure to soil, sediment, surface water (where applicable), and groundwater (where applicable). Risk calculated for the recreational child, park worker, and construction worker is acceptable (HI less than 1 and carcinogenic risk less than $1x10^{-4}$). The recreational child resulted in a hazard index of 0.4 and a cancer risk of 8×10^{-5}. The park worker resulted in a hazard index of 0.2 and a cancer risk of 5×10^{-5}. The primary constituents driving the cancer risk are dibenz(a,h)anthracene and benzo(a)pyrene in surface water. These two constituents were only detected in one out of 22 samples. In addition, the ditch is usually dry except during storm period. The vegetation observed in the ditches, i.e., cattail, verifies this conclusion since cattails prefer saturated soil conditions to flooded conditions. Therefore, the risks driven by these two constituents are most likely lower than indicated by the mini-risk assessment. Under the construction worker scenario, the hazard index is 0.3 and the cancer risk is 9×10^{-8}. The primary driver for non-carcinogenic risk is exposure to cadmium in soils. Mercury, which was also detected above background levels, did not contribute to risk.



EXPOSURE ROUTE	PARK WORKER	RECREATIONAL VISITOR (CHILD)	CONSTRUCTION WORKER
INHALATION	●	●	●
INGESTION	●	●	●
DERMAL CONTACT	●	●	●
INGESTION	●	●	NA
INHALATION	NA	●	NA
DERMAL CONTACT	NA	●	NA
INGESTION	NA	NA	NA
DERMAL CONTACT	●	●	NA

● PATHWAY CONSIDERED TO POSE POTENTIAL RISK

X PATHWAY NOT CONSIDERED

NA NOT APPLICABLE TO RECEPTOR

PARSONS
PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
SEAD-63 MISCELLANEOUS COMPONENTS BURIAL SITE EE/CA

DEPT ENVIRONMENTAL ENGINEERING
DWG NO 734364-01001

FIGURE 2-12
EXPOSURE PATHWAY SUMMARY FOR CONSERVATION AND RECREATION SCENARIO

SCALE NA
DATE OCTOBER 1999

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TABLE 2-15
CALCULATION OF TOTAL NONCARCINOGENIC AND CARCINOGENIC RISKS
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	EXPOSURE/RISK CALCULATIONS Table Number	HAZARD INDEX	CANCER RISK
PARK WORKER	Inhalation of Dust in Ambient Air	Table A-1	7E-07	1E-09
	Ingestion of Soil	Table A-4	1E-03	5E-08
	Dermal Contact to Soil	Table A-6	4E-04	8E-08
	Ingestion of Groundwater	Table A-9	1E-01	NQ
	Dermal Contact to Surface Water	Table A-13	4E-03	5E-05
	Dermal Contact to Sediment	Table A-14	1E-03	1E-06
	TOTAL RECEPTOR RISK (Nc & Car)		**2E-01**	**5E-05**
RECREATIONAL VISITOR (CHILD)	Inhalation of Dust Ambient Air	Table A-1	1E-06	5E-10
	Ingestion of Soil	Table A-4	4E-03	4E-08
	Dermal Contact to Soil	Table A-6	4E-04	2E-08
	Ingestion of Groundwater	Table A-8	3E-01	NQ
	Dermal Contact to Groundwater	Table A-11	5E-02	NQ
	Dermal Contact to Surface Water	Table A-13	4E-02	8E-05
	Dermal Contact to Sediment	Table A-15	1E-02	3E-06
	TOTAL RECEPTOR RISK (Nc & Car)		**4E-01**	**8E-05**
CONSTRUCTION WORKER	Inhalation of Dust in Ambient Air	Table A-1	9E-05	3E-08
	Ingestion of Soil	Table A-4	2E-01	4E-08
	Dermal Contact to Soil	Table A-6	2E-02	1E-08
	TOTAL RECEPTOR RISK (Nc & Car)		**3E-01**	**9E-08**
ADULT RESIDENT (Hazard Index)	Inhalation of Dust Ambient Air	Table A-2	3E-06	See risk below
	Ingestion of Soil	Table A-5	2E-03	
	Dermal Contact to Soil	Table A-7	3E-04	
	Ingestion of Groundwater	Table A-9	6E-01	
	Dermal Contact to Groundwater	Table A-12	1E-01	
	Dermal Contact to Surface Water	Table A-14	5E-03	
	Dermal Contact to Sediment	Table A-16	1E-03	
	TOTAL RECEPTOR RISK (Nc & Car)		**7E-01**	
CHILD RESIDENT (Hazard Index)	Inhalation of Dust Ambient Air	Table A-2	7E-06	See risk below
	Ingestion of Soil	Table A-5	2E-02	
	Dermal Contact to Soil	Table A-7	2E-03	
	Ingestion of Groundwater	Table A-9	1E+00	
	Dermal Contact to Groundwater	Table A-12	2E-01	
	Dermal Contact to Surface Water	Table A-14	4E-02	
	Dermal Contact to Sediment	Table A-16	1E-02	
	TOTAL RECEPTOR RISK (Nc & Car)		**2E+00**	
RESIDENT (Total Lifetime Cancer Risk)	Inhalation of Dust Ambient Air	Table A-2	See risk above	8E-09
	Ingestion of Soil	Table A-5		3E-07
	Dermal Contact to Soil	Table A-7		1E-08
	Ingestion of Groundwater	Table A-9		NQ
	Dermal Contact to Groundwater	Table A-12		NQ
	Dermal Contact to Surface Water	Table A-14		1E-04
	Dermal Contact to Sediment	Table A-16		4E-06
	TOTAL RECEPTOR RISK (Nc & Car)			**1E-04**

NQ = Not Quantified due to lack of toxicity data
Non-cancer risk is reported for adults and child residents separately. Cancer risk is considered over a lifetime, therefore the adult and child values are summed

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Table 2-16 shows the hazard quotients calculated for four ecological receptors, the deer mouse, American robin, mourning dove, and the short-tailed shrew. Only terrestrial receptors, mammalian and avian, were considered in the ecological mini-risk assessment since there is no evidence of aquatic receptors at SEAD-63. Exposure to terrestrial receptors is from surface soils at the site and biota ingestion. Hazard quotients were calculated for all four receptors in relation to a total of seven constituents, indicating that the soils and sediments as SEAD-63 do currently pose a potential ecological risk.

Based on the comparison to ARARs and regulatory guidelines, cadmium and mercury are the most significant constituent of concern, exceeding both guideline values and background levels. Based on the results of the mini-risk assessment, risk at the site is acceptable based on future use scenarios and ecological risk. However, cadmium is the most significant contributor to risk under the construction worker scenario.

2.9 REMOVAL ACTION JUSTIFICATION

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) states that a removal action may be conducted at a site when there is a potential threat to public health, public welfare, or the environment. An appropriate removal action is undertaken to abate, minimize, stabilize, mitigate, or eliminate the release or the threat of release at a site. Section 300.415(b)(2) of the NCP outlines factors to be considered when determining the appropriateness of a removal action, such as high levels of hazardous substances, pollutants, or contaminants in soils, largely at or near the surface, that may migrate; or the threat of fire or explosion.

Once it is determined that a removal action is appropriate, the removal is designated an emergency, time-critical, or non-time-critical removal. Emergencies are those situations in which response actions must begin within hours or days after the completion of the site evaluation. Time-critical removals are those in which, based on a site evaluation, it is determined that less than 6 months remains before response actions must begin. Non-time-critical removals are those in which it is determined that more than 6 months may pass before response actions must begin. SEAD-63 is assigned to this last category and is considered a voluntary, non-time-critical removal action.

When compared to ARARs and media-specific criteria, certain metals and organics exceed their respective criteria in all media. However, the results of the mini-risk assessment show that risk

TABLE 2-16
CALCULATION OF SOIL/SEDIMENT HAZARD QUOTIENTS - MAMMAL RECEPTORS
Engineering Evaluation/Cost Analysis - SEAD 63
Seneca Army Depot Activity

Constituent	Deer Mouse Exposure (mg/kg/day)[1]	Short-tailed Shrew Exposure (mg/kg/day)[1]	Toxicity Reference Value (mg/kg/day)[2]	Deer Mouse Hazard Quotient[3]	Short-tailed Shrew Hazard Quotient[3]
Volatiles					
Acetone	8.7E-01	2.9E-01	1.0E+01	0.09	0.03
Benzene	5.8E-03	2.8E-02	2.6E+01	0.00	0.00
Methyl ethyl ketone	1.1E-01	5.0E-02	1.8E+02	0.00	0.00
Toluene	1.1E-01	5.8E-01	2.6E+01	0.00	0.02
Total Xylenes	1.0E-02	4.8E-02	2.1E+00	0.00	0.02
PAHs					
Benzo(a)anthracene	3.9E-02	1.4E-01	1.0E+00	0.04	0.14
Benzo(a)pyrene	1.6E+00	7.0E+00	1.0E+00	1.62	6.99
Benzo(b)fluoranthene	1.4E-01	6.4E-01	1.0E+00	0.14	0.64
Benzo(k)fluoranthene	6.1E-02	2.7E-01	1.0E+00	0.06	0.27
Chrysene	5.7E-02	2.2E-01	1.0E+00	0.06	0.22
Dibenz(a,h)anthracene	5.4E-02	2.5E-01	1.0E+00	0.05	0.25
Fluoranthene	4.0E-01	1.9E+00	1.3E+00	0.32	1.55
Fluorene	6.5E-03	2.2E-02	1.3E+00	0.01	0.02
Indeno(1,2,3-cd)pyrene	1.2E-01	6.0E-01	1.0E+00	0.12	0.60
2-Methylnaphthalene	8.3E-04	2.8E-03	7.2E+00	0.00	0.00
Naphthalene	2.0E-03	4.8E-03	7.2E+00	0.00	0.00
Phenanthrene	4.3E-02	1.1E-01	1.0E+00	0.04	0.11
Pyrene	6.1E-02	1.7E-01	1.0E+00	0.06	0.17
Semi-volatiles					
Bis(2-ethylhexyl)phthalate	2.3E+00	1.2E+01	1.8E+01	0.13	0.67
Butylbenzylphthalate	1.4E-02	6.8E-02	1.6E+02	0.00	0.00
Carbazole	5.4E+00	2.8E+01	5.0E+00	1.08	5.62
Dibenzofuran	4.6E-03	2.1E-02	no data	--	--
Diethyl phthalate	1.9E-02	6.3E-02	4.6E+03	0.00	0.00
Di-n-butylphthalate	1.8E-02	8.6E-02	5.5E+02	0.00	0.00
Di-n-octylphthalate	1.0E+01	5.3E+01	1.8E+01	0.55	2.89
Phenol	6.5E-02	6.9E-02	no data	--	--
Pesticides					
4,4'-DDD	6.5E-05	2.2E-04	8.0E-01	0.00	0.00
4,4'-DDE	8.3E-05	1.4E-04	8.0E-01	0.00	0.00
4,4'-DDT	1.4E-04	4.7E-04	8.0E-01	0.00	0.00
Endosulfan I	5.1E-04	1.1E-03	5.0E-01	0.00	0.00
Endosulfan sulfate	3.3E-04	7.9E-04	2.5E-01	0.00	0.00
Endrin ketone	2.5E-04	9.7E-04	9.2E-02	0.00	0.01
Metals					
Cadmium	1.5E-02	1.3E-02	1.0E+00	0.02	0.01
Sodium	7.7E+01	3.3E+02	no data	--	--

(1) Receptor exposure from Table I-15.

(2) Toxicity reference value from Table A-10.

(3) Hazard quotient calculated as HQ = exposure rate / toxicity reference value
with HQ < 1, no effects expected
1 < HQ =< 10, small potential for effects
10 < HQ =< 100, potential for greater exposure to result in effects, and
HQ > 100, highest potential for effects.

TABLE 2-16 cont'd
CALCULATED SURFACE SOIL/SEDIMENT HAZARD QUOTIENTS - BIRDS
Engineering Evalutation/Cost Analysis - SEAD 63
Seneca Army Depot Activity

Constituent	Robin Exposure[1] (mg/kg/day)	Dove Exposure[1] (mg/kg/day)	Toxicity Reference Value[2] (mg/kg/day)	Robin Hazard Quotient[3]	Dove Hazard Quotient[3]
Volatiles					
Acetone	2.25E+00	5.83E-02	6.10E+02	0.00	0.00
Benzene	1.87E-02	1.10E-04	No data	–	–
Methyl ethyl ketone	2.80E-01	7.15E-03	No data	–	–
Toluene	3.64E-01	1.52E-03	No data	–	–
Total Xylenes	3.28E-02	2.66E-04	3.06E+02	0.00	0.00
PAHs					
Benzo(a)anthracene	2.43E-01	1.53E-02	2.85E+01	0.01	0.00
Benzo(a)pyrene	5.24E+00	5.50E-02	2.85E+01	0.18	0.00
Benzo(b)fluoranthene	6.56E-01	2.75E-02	2.85E+01	0.02	0.00
Benzo(k)fluoranthene	3.10E-01	1.47E-02	2.85E+01	0.01	0.00
Chrysene	3.10E-01	1.71E-02	2.85E+01	0.01	0.00
Dibenz(a,h)anthracene	2.46E-01	9.51E-03	2.85E+01	0.01	0.00
Fluoranthene	1.56E+00	3.73E-02	2.85E+01	0.05	0.00
Fluorene	2.62E-02	9.88E-04	2.85E+01	0.00	0.00
Indeno(1,2,3-cd)pyrene	5.53E-01	1.98E-02	2.85E+01	0.02	0.00
2-Methylnaphthalene	3.34E-03	1.26E-04	2.85E+01	0.00	0.00
Naphthalene	7.27E-03	2.53E-04	2.85E+01	0.00	0.00
Phenanthrene	2.17E-01	1.24E-02	2.85E+01	0.01	0.00
Pyrene	3.77E-01	2.51E-02	2.85E+01	0.01	0.00
Semi-volatiles					
Bis(2-ethylhexyl)phthalate	7.75E+00	4.06E-02	1.10E-01	70	0.37
Butylbenzylphthalate	5.29E-02	1.09E-03	No data	–	–
Carbazole	1.76E+01	6.86E-02	No data	–	–
Dibenzofuran	1.68E-02	3.50E-04	2.18E-01	0.08	0.00
Diethyl phthalate	3.82E+00	1.47E-02	1.10E-02	347	1.3
Di-n-butylphthalate	1.82E-02	1.01E-03	1.10E-02	1.7	0.09
Di-n-octylphthalate	3.28E+01	1.17E-01	1.10E-02	2984	10.7
Phenol	1.79E-01	4.39E-03	No data	–	–
		–			
Pesticides					
4,4'-DDD	4.37E-04	2.97E-05	5.60E-02	0.01	0.00
4,4'-DDE	7.99E-04	6.96E-05	5.60E-02	0.01	0.00
4,4'-DDT	9.22E-04	6.31E-05	5.60E-02	0.02	0.00
Endosulfan I	1.92E-03	7.63E-05	1.00E+00	0.00	0.00
Endosulfan sulfate	1.27E-03	5.11E-05	1.00E+00	0.00	0.00
Endrin ketone	1.34E-03	7.32E-05	3.00E-01	0.00	0.00
Metals					
Cadmium	9.22E-02	6.82E-03	1.45E+00	0.06	0.00
Sodium	2.78E+02	5.83E+00	No data	–	–

(1) Receptor exposure from Table I-15.

(2) Toxicity reference value from Table A-10.

(3) Hazard quotient calculated as HQ = exposure rate / toxicity reference value

with HQ < 1, no effects expected

1 < HQ =< 10, small potential for effects

10 < HQ =< 100, potential for greater exposure to result in effects, and

HQ > 100, highest potential for effects.

based on current conditions at SEAD-63 is within acceptable limits for the most likely future use scenarios. Radionuclides in sediment and surface water are elevated when compared to background levels in these media. However, sediment does not exhibit a dose equivalent above background greater than the NYSDEC TAGM and no surface water criteria have been established for radionuclides. ARARs for gross alpha in groundwater are exceeded in two groundwater samples. The source of the elevated levels of these compounds requires further investigation that will be incorporated as part of this removal action.

The mini-risk assessment and calculation of hazard quotients shows that there is an ecological risk. All four ecological receptors have hazard quotients greater than one for constituents detected in the soil and sediment. In particular, the avian species had hazard quotients indicating potential risk for four phthalate constituents detected in samples collected at SEAD-63. Hazard quotients indicated a risk for the mammalian species as well, particularly Benzo(a)pyrene, Carbazole, Fluoranthene, and Di-n-octylphthalate. These seven semi-volatile constituents pose a risk to the avian and mammalian species at the site, however, review of the mini-risk assessment indicates that threats are most-likely isolated to certain hot spots located in different areas of the site.

Although heavy metals are present in the soils surrounding the buried miscellaneous military items above background levels and the NYSDEC TAGMs, the mini-risk assessment described in **Section 2.8** does not demonstrate unacceptable risk from the metals in the soil at this site. However, the investigation has confirmed the presence of various military components. The presence of such buried objects, including buried drums, is of concern, since the nature of the drum contents are unknown. Furthermore, some buried components deposited at SEAD-63 may still be classified or sensitive and would need to be examined by appropriate military personnel for evaluation and declassification. The uncertainty of the nature of the buried components and the sensitivity of the materials that may remain in the disposal area is considered justification for performing a removal action at this site. While removal and control of the military items buried at the site is the focus of the planned removal action, the potential for soil contamination to be present that surrounds these items will also be addressed by this action. Goals for allowable soil concentrations, in particular for cadmium, will be developed, based upon existing conditions, and will be used as the basis for returning soil, segregated from the military items, to the excavation pit.

3.0 REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES

3.1 GENERAL STATEMENT OF THE REMOVAL ACTION OBJECTIVES

Removal action objectives and site-specific considerations are developed as a basis for identifying appropriate removal action alternatives. Removal action objectives must protect human health and the environment, and address contaminants of concern, exposure routes, and receptors. Applicable or relevant and appropriate requirements (ARARs) that establish cleanup standards are also used to identify removal action objectives. In New York State, the acronym ARARs is not used, but is replaced with the term New York State Standards, Criteria, and Guidelines (SCGs), as presented in the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #HWR-90-4030. The removal action must be compatible with long-term remedial objectives at the site.

There are several general objectives to be considered for this removal action. These are as follows:

1. Remove radioactive containing materials that may provide a source for future contamination.
2. Remove soils impacted by radionuclide or heavy metals.
3. Dispose or treat materials and/or soils at an approved facility.

Once source materials are removed, confirmatory sampling will be performed to confirm that site specific criteria are met for chemical contaminants of concern and that sufficient data are collected to determine the final radiological survey status of the site. Site specific criteria for chemical contaminants of concern and the radiological survey that will be performed once the removal action has been performed are discussed in **Section 3.3**.

3.2 ARARS STANDARDS, CRITERIA AND GUIDELINES (SCGS)

Pursuant to Section 300.415(i) of the NCP, the removal action for the site "shall, to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws." ARARs are used to identify removal action objectives, formulate removal action alternatives, govern the implementation and operation of a selected removal action, and evaluate the appropriate extent of site cleanup.

In 40 CFR 300.5, EPA defines applicable requirements as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are defined as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

Any standard, requirement, criterion, or limitation under any federal environmental or state environmental or facility siting law may be either applicable or relevant and appropriate to a specific action. The only state laws that may become ARARs are those promulgated such that they are legally enforceable and generally applicable and equivalent to or more stringent than federal laws. A determination of applicability is made for the requirements as a whole, whereas a determination of relevance and appropriateness may be made for only specific portions of a requirement. An action must comply with relevant and appropriate requirements to the same extent as an applicable requirement with regard to substantive conditions, but need not comply with the administrative conditions of the requirement.

Three categories of ARARs have been analyzed: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs address certain chemicals or a class of chemicals and relate to the level of contamination allowed for a specific pollutant in various environmental media (water, soil, and air). Location-specific ARARs are based on the specific setting and nature of the site. Action-specific ARARs relate to specific actions proposed for implementation at a site.

3.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are usually health or risk-based standards limiting the concentration of a chemical found in or discharged to the environment. They govern the extent of site remediation by providing actual cleanup levels, or the basis for calculating such levels for specific media. These requirements may apply to air emissions during the removal action. A number of federal and state regulations may be used for this site. These include the following:

Federal:

- Resource Conservation and Recovery Act (RCRA), Groundwater Protection Standards and Maximum Concentration Limits (40 CFR 264, Subpart F)
- Atomic Energy Act, Standards for Protection Against Radiation (10 CFR 20 subpart D)
- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book)
- Clean Air Act. Standards for Radionuclides (40 CFR 61.22 and .102)
- Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (40 CFR 141.11-.16)

New York State:

- New York State Codes, Rules and Regulations (NYCRR) Title 6, Chapter X
- New York Groundwater Quality Standards (6 NYCRR 703)
- New York Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (10 NYCRR 5)
- New York Surface Water Quality Standards (6 NYCRR 702)
- New York State Raw Water Quality Standards (10 NYCRR 170.4)
- New York RCRA Groundwater Protection Standards (6 NYCRR 373-2.6 (e))
- New York State Department of Environmental Conservation, Division of Water, Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values, November 15, 1990
- New York State Department of Environmental Conservation, Division of Hazardous Substances Regulation, Technical and Operational Guidance Series, Technical Administrative Guidance Memorandum: 4003, Cleanup Guideline for Soils Contaminated with Radioactive Materials (TAGM 4003).

- New York State Department of Environmental Conservation, Division of Hazardous Waste Remediation, Technical and Operational Guidance Series, Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels, HWR-94-4046 (TAGM 4046).

- New York State Department of Environment Conservation, Division of Fish and Wildlife, Division of Marine Resources. Technical Guidance for Screening Contaminated Sediments, July 1994.

- Surface Water and Groundwater Classifications and Standards (6 NYCRR 700-705)

- Declaration of Policy, Article 1 Environmental Conservation Law (ECL)

- General Functions. Powers. Duties and Jurisdiction. Article 3 Environmental Conservation Law, Department of Environmental Conservation

- ECL, Protection of Water. Article 15. Title 5.

- Use and Protection of Waters. (6 NYCRR. Part 608)

- New York State Title 12. Part 38. Ionizing Radiation Protection, Acceptable Surface Contamination Levels (12 NYCRR Part 38)

3.2.2 Location-Specific ARARs

Location-specific ARARs govern natural site features such as wetlands, floodplains, and sensitive ecosystems, and manmade features such as landfills, disposal areas, and places of historic or archaeological significance. These ARARs generally restrict the concentration of hazardous substances or the conduct of activities based solely on the particular characteristics or location of the site. Federal and State regulations that may apply to this removal action include the following:

Federal:

- Executive Orders on Floodplain Management and Wetlands Protection (CERCLA Floodplain and Wetlands Assessments) #11988 and 11990
- National Historic Preservation Act (16 USC 470) Section 106 et seq. (36 CFR 800) (Requires Federal agencies to identify all affected properties on or eligible for the National Register of Historic Places and consult with the State Historic Preservation Office and Advisory Council on Historic Presentation)
- RCRA Location Requirements for 100-year Floodplains (40 CFR 264.18(b)).
- Clean Water Act, Section 404, and Rivers and Harbor Act, Section 10, Requirements for Dredge and Fill Activities (40 CFR 230)
- Wetlands Construction and Management Procedures (40 CFR 6, Appendix A).
- USDA/SCS - Farmland Protection Policy (7CFR 658)
- USDA Secretary's memorandum No. 1827, Supplement 1, Statement of Prime Farmland, and Forest Land - June 21, 1976.
- EPA Statement of Policy to Protect Environmentally Significant Agricultural Lands - September 8, 178.
- Farmland Protection Policy Act of 1981 (FPPA)(7 USC 4201 et seq).
- Endangered Species Act (16 USC 1531).
- Fish and Wildlife Coordination Act (16 USC 661)
- Wilderness Act (16 USC 1131).

New York State:

- New York State Freshwater Wetlands Law (ECL Article 24, 71 in Title 23).
- New York State Freshwater Wetlands Permit Requirements and Classification (6 NYCRR 663 and 664).
- New York State Floodplain Management Act and Regulations (ECL Article 36 and 6 NYCRR 500).
- Endangered and Threatened Species of Fish and Wildlife Requirements (6 NYCRR 182).
- New York State Flood Hazard Area Construction Standards.

3.2.3 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based- limitations that control actions at hazardous waste sites. Action-specific ARARs generally set performance or design standards, controls, or restrictions on particular types of activities. To develop technically feasible alternatives, applicable performance or design standards must be considered during the development of all removal alternatives. Action-specific ARARs are applicable to this site. The action-specific ARARs to be used will be determined by the Army based upon the technology chosen. Federal and State regulations that may apply include the following:

Federal:

- RCRA Subtitle C Hazardous Waste Treatment Facility Design and Operating Standards for Treatment and Disposal systems, (i.e., landfill, incinerators, tanks, containers, etc.) (40 CFR 264 and 265); Minimum Technology Requirements.
- RCRA, Subtitle C, Closure and Post-Closure Standards (40 CFR 264, Subpart G).
- RCRA Groundwater Monitoring and Protection Standards (40 CFR, Subpart F).
- RCRA Generator Requirements for Manifesting Waste for Off-site Disposal (40 CFR 262).

- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 263).

- RCRA, Subtitle D, Non-Hazardous Waste Management Standards (40 CFR 257).

- Safe Drinking Water Act, Underground Injection Control Requirements (40 CFR 144 and 146).
- RCRA Land Disposal Restrictions (40 CFR 268) (On and off-site disposal of excavated soil).

- Clean Water Act, - NPDES Permitting Requirements for Discharge of Treatment System Effluent (40 CFR 122-125).

- Effluent Guidelines for Organic Chemicals, Plastics and Resins (Discharge Limits) (40 CFR 414).
- Clean Water Act Discharge to Publicly - Owned Treatment Works (POTW) (40 CFR 403).

- DOT Rules for Hazardous Materials Transport (49 CFR 107, 171.1-171.500).

- Occupational Safety and Health Standards for Hazardous Responses and General Construction Activities (29 CFR 1904, 1910, 1926).

- SARA (42 USC 9601)

- OSHA (29 CFR 1910.120)

- Clean Air Act (40 CFR 50.61)

New York State:

- New York State Pollution Discharge Elimination System (SPDES) Requirements (Standards for Stormwater Runoff, Surface water, and Groundwater discharges (6 NYCRR 750-757).

- New York State RCRA Standards for the Design and Operation of Hazardous Waste Treatment Facilities (i.e., landfills, incinerators, tanks, containers, etc.); Minimum Technology Requirements (6 NYCRR 370-373).

- New York State RCRA Closure and Post-Closure Standards (Clean Closure and Waste-in-Place Closures) (6 NYCRR 372).

- New York State Solid Waste Management Requirements and Siting Restrictions (6 NYCRR 360-361), and revisions/enhancements effective October 9, 1993.

- New York State RCRA Generator and Transporter Requirements for Manifesting Waste for Off-Site Disposal (6 NYCRR 364 and 372).

3.3 SITE-SPECIFIC CLEAN-UP GOALS

Site specific clean-up goals for chemicals and radionuclides of concern are discussed below.

3.3.1 Clean-Up Goals for Non-Radionuclides of Concern in Soil

Cadmium is the only metallic constituent of concern in soil at SEAD-63. **Table 3-1** presents the site clean-up goals established for soil remediation at SEAD-63. The clean up goals shown in **Table 3-1** were developed based TAGM values developed for SEAD-63 and on the streamlined risk evaluation results presented in **Section 2 of Appendix F**. While the risk based number is significantly higher than the TAGM 2.46 mg/kg value, the more conservative TAGM value has been adopted for cadmium clean-up goal. This value will be reviewed based on the results of confirmatory sampling.

The clean up goal development for this constituent was based on the assumption that all constituents existing at the site other than cadmium remain at their present levels. The 50 mg/kg goal represents the highest concentrations of cadmium that could exist at the site, all other constituents being present at their current levels, and still result in acceptable human and ecological risk (i.e., HQ<1, carcinogenic risk < 1×10^{-4}, and EQ<1). Supporting risk calculations are provided in **Appendix F**.

3.3.2 Clean-Up Goals for Radionuclides of Concern in Soil

Soil samples will be collected from the site after the removal action has been performed in support of a final status survey. The final status survey will be conducted to demonstrate compliance with the release criterion. The NYSDEC TAGM of 10 mrem/yr above background for unrestricted use is the goal set for the release criterion. The final status survey will be performed in accordance with the Multi-Agency Survey and Site Investigation Manual (MARSSIM) for a Class II area, the

Table 3-1
Preliminary Clean Up Goals for Soil
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity, Romulus, NY

Clean up Goals for Chemicals of Concern

Cadmium	50 mg/kg (1b)

Clean up Goals for Radionuclides

	Background	Preliminary DCGL - pCi/g (3)			
Isotope	Screening Level (2)	Park Wkr (4)	Rec Child (4)	Const. Wkr (5)	Residential (6)
Ac-227	0.4	10.52	15.86	3.412	1.6
Cs-137	0.7	8.473	9.759	6.839	12.2
Co-57	0.1	56.06	64.56	45.31	94.2
Co-60	0.305	1.771	2.04	1.432	3
Lead-210	4.3	151	1156	22.57	2.79
Pm-147					49350
Pu-239/240	0.2	260	2820	34.83	20
Ra-226	2.315	2.55	2.944	2.033	0.12
Ra-228	2.645	4.765	5.517	3.749	2.35
Th-228		2.791	3.225	2.211	3.89
Th-230	1.75	924.6	9481	110.9	0.33
Th-232	1.81	192	2813	22.25	1.3
Tritium	16.51	52930	2148000	52020	80
U-233/234	1.14	2048	21860	24.92	38.5
U-235	0.305	36.68	42.88	27.09	6.7
U-238	1.21	191.3	238.6	104.2	73.6

(1a) Based on TAGM value.; 1b) based on health risk calculation

(2) Background Screening Level set to 95th percentile value. If 95th percentile exceeded the max value (due to high SQLs), the maximum value was used instead.

(3) Derived using RESRAD and a dose equivalent of 10 mrem/yr. Assumed an impacted area (above background) of 3439 m2.

(4) The Preliminary DCGLs derived for SEAD-63 for the Park Worker and the Recreational Child scenerios included the following pathways: dermal contact to soil, inhalation of dust in ambient air, soil ingestion, and ingestion of groundwater.

(5) The Preliminary DCGLs derived for SEAD-63 for the Construction Worker scenerio included the following pathways: dermal contact to soil, inhalation of dust in ambient air, and soil ingestion.

(6) Residential Preliminary DCGLs were derived for SEAD-12 and include the following pathways: dermal contact to soil, inhalation of dust in ambient air, ingestion of soil, ingestion of groundwater, ingestion of contaminated produce grown in contaminated soil, ingestion of contaminated milk and meat taken up by cows grazing on contaminated plants, and radon.

The ESI data indicate that radionuclides are not present in the soil above background levels. However, in the event that confirmatory sampling performed in support of the final status survey indicates the presence of radionuclides above background levels, site specific clean up goals will be established using RESRAD. The RESRAD model uses dose assessment methodology to derive site-specific soil guidelines. These guidelines, referred to as DCGLs (derived concentration guideline levels) in MARSSIM, will be used as described in MARSSIM to determine if the site may be released for unrestricted use. Preliminary guidelines have been established using RESRAD and site specific information for SEAD-63. These guidelines were derived based on an exterior dose limit of 10 mrem per year above background (NYSDEC TAGM). This dose limit was input into RESRAD to obtain a dose derived guideline level (DCGL) that is expressed in the same units as the final radiological survey soil data (i.e., pCi/g). The RESRAD model uses dose assessment methodology recommended for use in deriving site-specific soil guidelines. Using the permissible dose limit, RESRAD was run to calculate site specific DCGLs for each radionuclide potentially present at SEAD-63. The DCGL derived is the maximum concentration of the radionuclide above background that would yield the permissible dose limit if it were the only radionuclide present. This value is independent of the concentration of radionuclides found at SEAD-63, but is dependent on the exposure scenario. DCGLs were calculated using RESRAD for three of the human receptors shown in **Figure 2-12,** the park worker, construction worker, and recreational child. DCGLs were also derived for a residential scenario for comparison purposes only, since such a receptor is highly unlikely under the planned future land use of the site. Soil clean-up guidelines for SEAD-63 (shown in **Table 3-1**) will be set at the lowest DCGLs calculated for any of the three likely future use scenarios. Assumptions and input values used in RESRAD to derive these guidelines, as well as model output are presented in **Appendix E**.

The preliminary DCGLs presented in **Table 3-1** would be used in the following manner to establish final DCGLs. Data collected from remaining soils at SEAD-63 after site remediation would be used in the following manner. Radionuclides distinguishable from background will be identified. The activity fraction of each radionuclide above background will be calculated by dividing the average activity of a single radionuclide by the sum of the average activities of all radionuclides distinguishable from background. This fraction, f, will then be multiplied by the DCGL shown in **Table 3-1** to determine the radionuclide specific DCGL that contributes to the total dose. This DCGL will be added to the site background soil data set (given in **Appendix D**), and used to compare the site data set by running the Wilcoxon Rank Sum test, as described in Section 8.4.1 of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). MARSSIM provides guidance for planning and evaluating environmental radiological surveys conducted to demonstrate compliance with dose-based regulations (e.g. the NYSDEC TAGM of

10 mrem/yr). If the null hypothesis established in MARSSIM is rejected (i.e. the median concentration in the survey unit exceeds the reference area by more than the DCGL), then acceptable clean up goals have been achieved. The DCGLs shown in **Table 3-1** are considered preliminary since their application depends on which radionuclides are distinguishable from background during confirmatory sampling and what area is actually affected by those radionuclides.

In addition to the above analysis, a DCGL for elevated measurement comparison ($\mathrm{DCGL}_{\mathrm{EMC}}$) will be derived and used to compare each data point from the confirmatory sampling to ensure that no single data point indicates the presence of a hot spot. The $\mathrm{DCGL}_{\mathrm{EMC}}$ will be derived by decreasing the affected area used in RESRAD in deriving the DCGL to account for the largest area that may be missed by the sampling grid used to perform the final status survey. MARSSIM discusses the derivation and use of the $\mathrm{DCGL}_{\mathrm{EMC}}$ in Section 8.5.1 of MARSSIM.

3.3.3 Discharge Criteria for Groundwater

Proposed discharge criteria for groundwater or surface water generated during the removal action (e.g. dewatering operations) are provided in **Table 3-2**. These criteria are consistent with requirements defined in 6 NYCRR Part 380 and based on radiation dose limits for individual members of the public.

Table 5-3
Discharge Criteria for Water
SEAD-63 Action Memorandum
Seneca Army Depot Activity, Romulus, NY

Radionuclides Detected in SEAD-63 Soils	Criteria for Effluent Released to Unrestricted Areas (1,2)		Release to Sewers (3,4)	
	uCi/mL	pCi/L	uCi/mL	pCi/L
Cs-137	1.00E-06	1000	1.00E-05	10,000
Pb-210	1.00E-08	10	1.00E-07	100
Ra-226	6.00E-08	60	6.00E-07	600
Ra-228	6.00E-08	60	6.00E-07	600
Th-228	2.00E-07	200	2.00E-06	2,000
U-235	3.00E-07	300	3.00E-06	3,000
U-238	3.00E-07	300	3.00E-06	3,000

(1) Table II "Effluent Concentrations", 6 NYCRR Part 380-11.7.

(2) The concentration values given in Table II are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 50 mREM to "reference man" (6 NYCRR Part 380-11.4).

(3) Table III "Releases to Sewers", 6 NYCRR Part 380-11.7.

(4) The concentration values given in Table III are such that, if the sewage released by the licensee were the only source of water indested by a reference man during a year, woul result in a committed effective dose equivalent of 500 mREM.

Substance[1]		Category[2]	Maximum Allowable Concentration (ug/L)
Aluminum		A	2000
Arsenic		A	50
Cadmium		A	10
Copper		A	1000
Iron*		A	600/1000
Lead		A	50
Manganese*		A	600/1000
Bis(2-ethylhexyl) phthalate		A	5
Phenol		A	2

1) Substance from Table 5 of TOGS 1.1.1 - Effluent Limitations (Class GA)

2) Catagory A effluent limitations from regulation (6 NYCRR 703.6)

* For Iron and Manganese limitation of 600 ug/L for each or 1000 ug/L combined.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

4.1 EVALUATION METHODOLOGY

The purpose of this removal action is to remove debris and impacted soils and thereby reduce the potential for further degradation of groundwater, soils, and possibly nearby sediments and surface waters. This section discusses the methodology that was employed to select the appropriate treatment technology for this removal action. The evaluation followed the EPA guidance, where applicable.

The first step in the technology selection process was to screen potential technologies based upon their demonstrated ability to remove debris. Soils at SEAD-63 have been impacted primarily by metals, although metals were not detected above clean up goals established in **Table 3-1**. Radionuclides targeted during the ESI are not present in soils above background levels. The selection process accounted for site specific conditions including geology, hydrogeology, and the nature and extent of contamination. Other factors considered in the initial screening evaluation included the permanence of the solution, in regards to removing the source of contamination and the potential effect on future remediation operations. Those technologies passing the initial screening process were further evaluated. The purpose of evaluating removal action options is to provide decision makers with sufficient information to select the most appropriate technology for the removal action.

The first evaluation criterion considered was effectiveness. This criterion as defined in *Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA* (EPA, 1988c) focuses on (1) the potential effectiveness of process options in handling the estimated areas and volumes of contaminated soils and meeting the removal action clean up objectives; (2) the potential impacts to human health and the environment during the construction and implementation phase; and (3) how proven and reliable the process is with respect to the contaminants and conditions at the site. Factors considered in the evaluation of effectiveness included the following:

- Protection of the community during the removal action,
- Protection of workers during the removal action,
- Threat reduction,
- Time until the removal action objectives are met,

- Compliance with ARARs,
- Impact to the environment,
- Potential exposure to remaining risks,
- Reduction of toxicity, mobility, or volume,
- Long-term effectiveness and permanence, and
- Long term remediation goals.

Implementation encompasses both the technical and administrative feasibility of implementing a technology process. Technical feasibility refers to the ability to construct, reliably operate and meet the technology-specific regulations taking into account specific site conditions. Administrative feasibility refers to the ability to obtain approvals from the various agencies, the availability of treatment, storage and disposal services and capacity, and the requirements for, and availability of, specific equipment and technical specialists. In summary, factors that were examined in regards to implementation included the following:

- Technical feasibility, and
- Administrative feasibility (including availability).

Preliminary cost estimates were developed for each alternative using US Army Corps of Engineers MCACES for Windows Version 1.2, as well as published information, guidance documents, vendor quotes, and engineering judgment. These estimates are not meant to be definitive, but serve as a basis for comparison. Capital costs consist of direct (construction) and indirect (nonconstruction and overhead) costs. Direct costs may include the following:

- Construction costs,
- Equipment costs,
- Land and site - development cost,
- Disposal costs,
- Site restoration costs, and
- Equipment decontamination costs

Indirect costs consist of the following:

- Health and safety costs,
- Engineering costs,
- Contingency allowances,
- Overhead costs.

Operation and Maintenance Costs include annual groundwater monitoring in the existing plus four newly installed wells plus a sampling report. Groundwater monitoring will be conducted for five years.

4.2 INITIAL SCREENING

4.2.1 Screening of Technologies

Based on the available data and the discussions in **Sections 2.8 and 3.3** of this report, the soils at SEAD-63 do not appear to cause a risk due to based on the chemicals present. Furthermore, radionuclides detected do not exceed background. However, the investigation conducted has confirmed the presence of various military components. The presence of such buried objects, including buried drums, is of concern, since the nature of the drum contents are unknown. Furthermore, some buried components deposited at SEAD-63 may still be classified or sensitive and would need to be examined by appropriate military personnel for evaluation and declassification. The uncertainty of the nature of the buried components and the sensitivity of the materials that may remain in the disposal area is considered justification for performing a removal action at this site.

While removal and control of the military items buried at the site is the focus of the planned removal action, the potential for soil contamination to be present that surrounds these items will also be addressed by this action. Goals for allowable soil concentrations, in particular for cadmium, have been developed (see **Table 3-1**), based upon existing conditions, and will be used as the basis for returning soil, segregated from the military items, to the excavation pit.

Because limited data exists for the groundwater, any groundwater removed during the excavation would be stored on-site in tanks until further characterization is performed. If the water meets the criteria established in **Table 3-2**, the water may be discharged directly or into a sanitary sewer. If criteria are not met, treatment will be necessary prior to discharge.

To address potential concerns about sediment samples found to exceed NYSDEC Technical Guidance levels. Limited sediment removal will be completed in select areas.

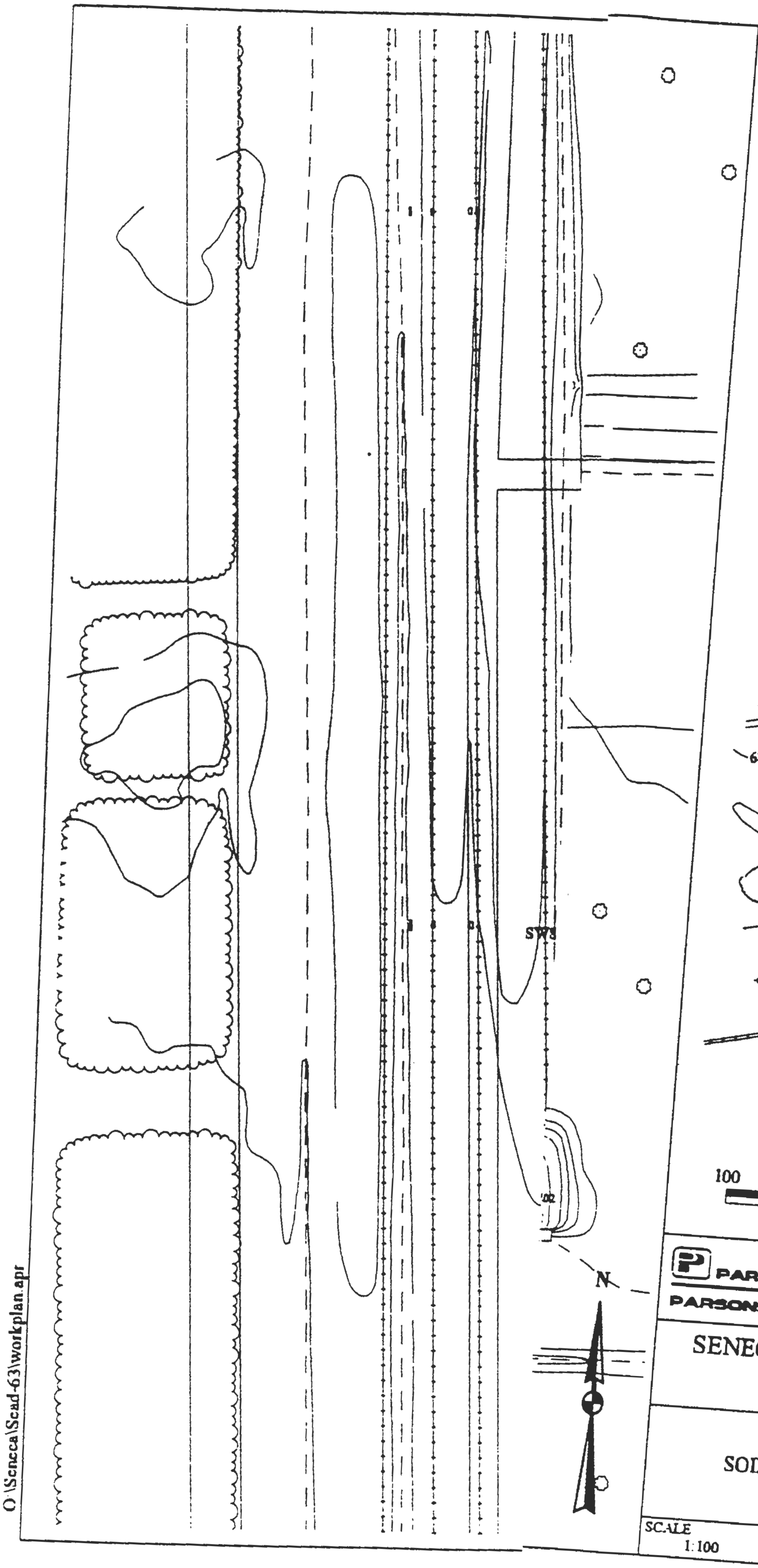
4.3 DETAILED ANALYSIS OF OPTION

Only one alternative is considered in this report. Because the impetus for the removal action at this site is the presence, of debris, and due to the uncertain nature of this debris, excavation, rather than any sort of in situ treatment of these items is logical. Excavated debris would be disposed off-site while soils, depending on confirmation sampling, would most likely be backfilled into the excavation pit.

4.3.2 Excavation / Off-Site Disposal of Debris/On-Site Backfill of Soils

Excavation, off-site disposal of debris and on-site backfilling of soils involves the excavation of approximately 4,500 CY of soil and debris and approximately 40 CY of sediment (see **Figure 4-1**), sorting of the excavated materials, off-site disposal of sorted materials, and backfilling of soils. **Figure 4-2** shows the decision process for how waste would be sorted and disposed once excavated from the site. Soil and debris would be stockpiled in a bermed staging area. If necessary, debris will be segregated from the soils through use of a vibratory screen. It is estimated based on test pit logs that there are approximately 1,000 cubic yards of debris within the disposal pits. All debris will be screened by Army personnel to determine if any parts or components are classified. Classified parts will be disposed at Army designated locations. In addition, debris will be scanned for the presence of radioisotopes. Any debris found to be radioactive during scanning or known to be a source of radioactivity will be sent to a facility authorized to accept such materials. Any debris free of radioactivity will be recycled or disposed in an industrial landfill.

Soils excavated from SEAD-63 will be scanned for high and low energy gamma radiation. Soil will be placed into one of two stockpiles. Soil will be screened prior to excavation and if the soil exhibits radiation greater than the background it will be placed in one pile; soils exhibiting radiation equal to or less than background will be placed in another pile. Confirmatory soil sampling will be performed on the pile exhibiting radiation above background to show whether gamma radiation is



LEGEND

▨ SOIL TO BE EXCAVATED TO AVERAGE DEPTH OF 5 FEET

■ SEDIMENT TO BE EXCAVATED TO AVERAGE DEPTH OF 6 INCHES, WIDTH OF 6 FEET, AND 25 FEET UP AND DOWN GRADIENT

▲ SURFACE WATER/SEDIMENT SAMPLE (ESI, 1994)

▲ APPROXIMATE SURFACE WATER/SEDIMENTSAMPLE (DEC, 1997)

● MONITORING WELL (ESI, 1994)

◩ TEST PIT (ESI, 1994)

PAVED ROAD

680 GROUND CONTOUR AND ELEVATION

WETLAND

BRUSH

CHAIN LINK FENCE

∘ UTILITY POLE

✦ APPROXIMATE LOCATION OF FIRE HYDRANT

RAILROAD

100 0 100
(feet)

PARSONS
PARSONS ENGINEERING SCIENCE, INC.

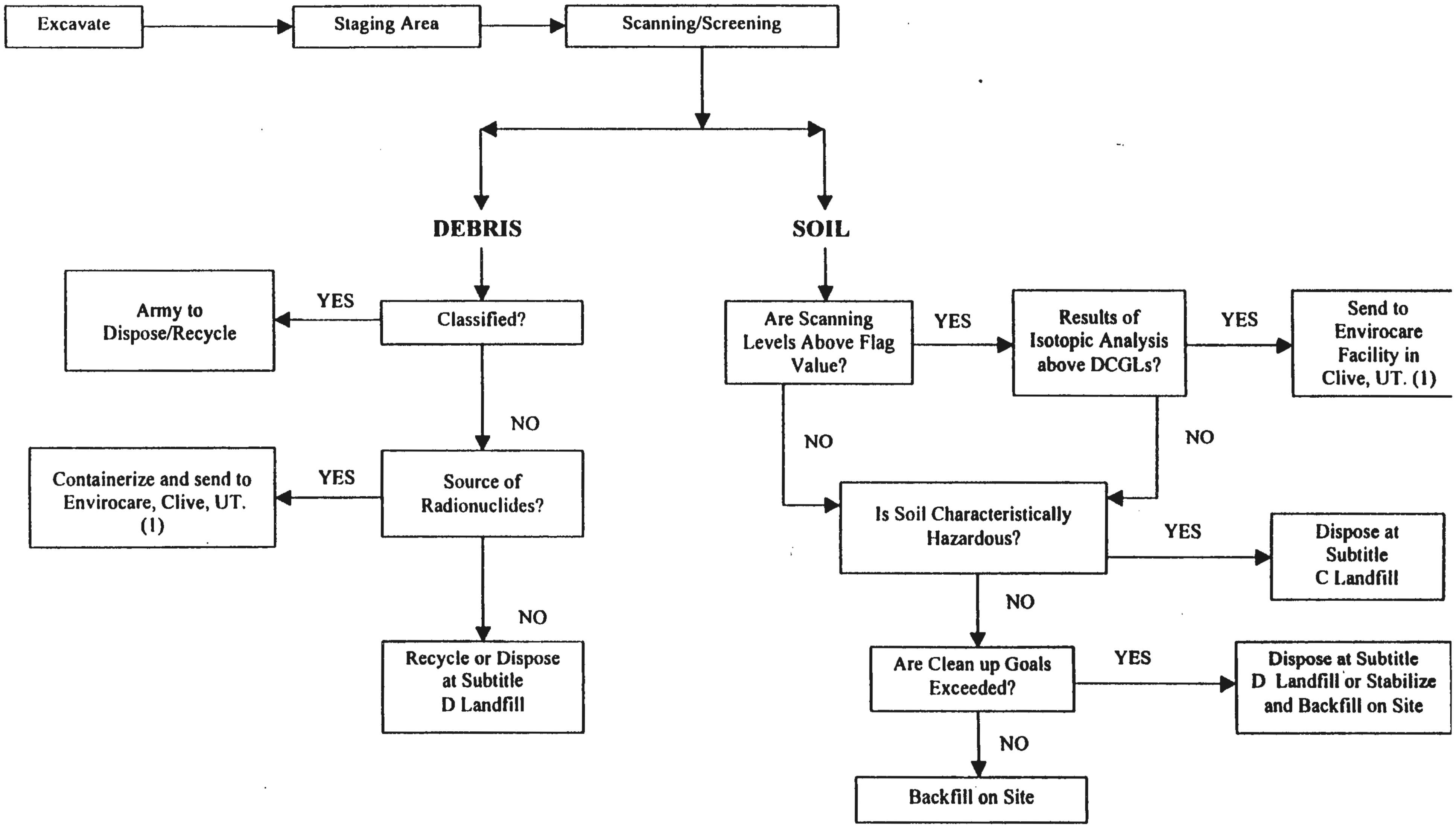
SENECA ARMY DEPOT ACTIVITY
SEAD -63
EE/CA

FIGURE 4-1
SOIL AND SEDIMENT AREAS
TO BE EXCAVATED

SCALE	DATE	REV
1:100	MAY 2001	SHEET 1 OF 1

O:\Seneca\Sead-63\workplan.apr

FIGURE 4-2
DISPOSAL DECISION FLOW CHART
SEAD-63 DECISION EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, N.Y.



NOTE: [illegible] ccepts low level Radioactive Waste above the background level or not. If levels of radionuclides and cadmium do not exceed the clean up goals proposed on **Table 3-1**, soil will be backfilled into the excavation pit. Although certain heavy metals were found above TAGMs, the levels do not indicate that the soils pose a risk nor would be deemed hazardous. Samples will also be collected for metals and semivolatiles analysis to confirm this prior to disposal.

Although not anticipated, if soil samples indicate that radioisotopes exist in soil above the clean up goals established in **Table 3-1** and discussed in **Section 3.3.2**, such soils will be transported to a facility licensed to accept such material. For evaluation purposes, it is assumed that soil having elevated radioisotopes will be transported to the Envirocare facility in Clive, UT, which accepts bulk waste shipments of low level radioactive waste material.

Sediment will be excavated from drainage ditches at locations shown in Figure 4-1. However, excavated sediment will not be screened for radiation and will be placed in the soil pile with radiation lower than the background level.

Groundwater collected from dewatering activities during excavation will be stored in frac tanks on-site and analyzed for metals and radionuclides to determine if the groundwater requires treatment prior to discharge. **Table 3-2** shows concentrations dictated by 12 NYCRR Part 380 for releases to sewers for the radionuclides detected in the soils at SEAD-63 as well allowable effluent concentrations for select metals and semi-volatiles (6 NYCRR 703.6). If the criteria are not met, treatment appropriate for metals or radionuclides of concern will be implemented prior to discharge of the water.

Upon completion of the removal action, confirmatory soil samples will be collected to confirm that all residual soil satisfied final status survey requirements as outlined in MARSSIM (NUREG-1575, EPA 402-R-97-016, December 1997). As these surveys are designed to compare site data sets to reference data sets, the DQOs presented in Section 3.5 of the Project Scoping Plan were used to determine the minimum number of data points that are needed from the site and reference sites. This discussion has been provided in **Appendix G**. The minimum number of data points was determined to be 34, or 17 from each survey unit and the reference area. Following NUREG and MARSSIM guidance, this number was increased by 20%, to 20 for each data set, to allow for broken samples and bad, missing, or rejected data. Reference area samples have already been collected for the site.

SEAD-63 had been classified as a Class II survey unit in the Project Scoping Plan. Class II areas have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the derived concentration guideline level (DCGL). The area of SEAD-63 is within the suggested maximum area for a Class II area provided by MARSSIM. Therefore, twenty confirmatory samples will be adequate to satisfy data quality objectives in the determination of final survey status.

To meet the objective of the final status survey at SEAD-63, derived concentration guideline levels (DCGLs), against which the radiological survey data will be screened, are established prior to proceeding with the surveys. Guideline values are expressed in the same units as the survey instrumentation that will be used and are based upon pre-selected dose or exposure limits or state or federal release criteria. These have been established in **Table 3-1**.

Confirmatory sampling will be performed below the excavated soils and analyzed for the constituents of concern listed in **Table 3-1**. No confirmatory samples will be collected in association with the sediment removal.

4.3.2.1 Effectiveness

Removal of the debris and potentially some soils at SEAD-63 would effectively eliminate the source of any future contamination at this site and prevent any further impact on groundwater or nearby ditches. Groundwater removed during the excavation activities would be tested and if found to contain metals contamination or radionuclides, treated prior to discharge.

4.3.2.2 Implementation

Excavation of soils from SEAD-63 may be readily implemented. The extent of the debris and metal and radionuclide impacted soils is well defined and accessible. A number of contractors are available who are very experienced in removing and transporting such material. Although not anticipated, off-site disposal of low level radioactive materials is somewhat difficult in that the most economical permitted facility to accept this waste is Envirocare in Clive, UT. It is not expected that soils will exceed clean up goals nor the Toxicity Characteristic Leaching Procedure (TCLP) limits. However, if cadmium concentrations for example, exceeded clean up goals, it would be taken

4.3.2.3 Cost

Preliminary capital costs for excavation, off-site disposal of debris and on-site backfilling of soil were developed using TRACES/MCACES for Windows v1.2 software. The estimated capital cost for this alternative is $944,000. Annual costs are estimated at $33,600. The present worth cost for this alternative is $1,090,000. Estimated construction time is 2 months. **Table 4-1** provides the cost breakdown, with cost backup and assumptions provided in **Appendix H.**

Table 4-1
Cost Estimate for Alternative for SEAD-63
Engineering Evaluation/Cost Analysis

Cost Component	Excavation of Soil & Debris Off-site Disposal of Debris and On-site Backfilling of Soils.
Mobilization and Preparation	$ 101,700
Sampling and testing (GW and soil)	$ 127,000
Site Work	$ 212,700
Groundwater Collection	$ 6,800
Disposal	$ 51,700
Site Restoration	$ 2,000
Demobilization	$ 40,700
Cost to Prime	**$ 542,600**
Field OH (4.9%)	$ 52,000
Home Office (4.9%)	$ 28,600
Profit (6.3%)	$ 38,500
Bond (1.4%)	$ 25,600
Cost to Owner	**$ 687,400**
Design Contingency (4.5%)	$ 30,900
Escalation (4.9%)	$ 35,900
Construction Contingency (11.7%)	$ 90,500
Other (3.4%)	$ 29,600
Construction Management (7.8%)	$ 69,900
Project Cost	**$ 944,000**

Operations and Maintenance (O&M)	
Annual Cost	$ 33,600
Present Worth of Annual Cost (5 years at 5%)	$ 145,500

TOTAL PRESENT WORTH COST	**$ 1,090,000**

5.0 RECOMMENDATION AND ANTICIPATED SCHEDULE

5.1 RECOMMENDATION

Excavation of the disposal pit area shown in **Figure 4-1** at SEAD-63 is recommended. Removal of military components from this area will reduce future risk of impacting the site. Soil and debris removed from the area will be screened for radionuclides. Debris will be disposed off-site and soils will be subject to confirmatory sampling prior to being backfilled on site. Any groundwater generated during the removal action will also be characterized as required, to determine the proper method for disposal or discharge.

The removal of sediment from select areas where risk and technical guidance levels are exceeded is recommended. This will reduce future risk associated with the site.

Groundwater sampling is recommended to evaluate the performance of the removal action, subsequent to its completion.

5.2 CONCEPTUAL DESIGN

Figure 4-2 shows the conceptual decision making process that will be used during removal of debris and soil at SEAD-63. A set of performance specifications will be developed as part of a bid package and will cover everything from mobilization to disposal to site restoration. These specifications will be completed once the proposed removal action has been approved.

5.2.1 Site-Specific Work Plans

The first step in the removal action will be developing site specific work, health and safety, and sampling and analysis plans. The work plan will address the steps necessary to complete the remediation, and will include, at a minimum, the following items:

- Mobilization,
- Site preparation,
- Site layout,
- De-watering design and construction plan,

- Groundwater removal and treatment (if necessary),
- Excavation plan,
- Stockpiling and segregation plans,
- Site restoration plan.

A site-specific health and safety plan will also be developed. Since this is a hazardous waste site, the plan, to be developed by the contractor, will be prepared in compliance with all applicable OSHA regulations. A requirement of the bid package will be that the contractor be in full compliance with all OSHA regulations, including proper training and medical monitoring programs. This plan will address air monitoring which will be conducted as part of the health and safety program.

The last plan to be developed will be a site-specific sampling and analysis plan. Included within the sampling and analysis plan will be a QA/QC plan. The sampling and analysis plan will address several specific areas. First, soil samples will be collected from the excavation. These samples will ensure that no soils remaining in the ground, exceed clean up goals and that MARSSIM final status survey objectives have been met. The statistical approach used in the SEAD-12 and SEAD-63 Project Scoping Plan (provided in **Appendix G**) will be developed to determine the number and location of the soil samples to be collected.

The next item to be considered in the sampling and analysis plan is post-treatment sampling. Both soil and groundwater will need to be sampled after treatment to ensure that all the treatment criteria have been met prior to discharging the groundwater and disposal of soil and other debris. Again, a statistical approach will be developed to determine the number and type of samples to be collected.

An important part of the sampling and analysis plan is the QA/QC plan. The QA/QC plan will describe the procedures to be followed to ensure that the data collected is valid, and will be accepted as evidence of a successful removal action. At a minimum, the QA/QC plan will address sampling procedures, analytical procedures, data validation and reduction procedures, and quality assurance samples (duplicates, blanks, etc.). The analytical methods specified will be acceptable to NYSDEC and EPA, and will have detection limits low enough to ensure that the treatment criteria have been met.

5.2.2 Mobilization and Site Preparation

Once the work plans have been approved, site preparation and mobilization will begin. The contractor will bring all the necessary equipment to the site, arrange for all required utilities, and obtain all necessary permits. If necessary, pads will be constructed for the equipment, and run on and run off controls will be constructed.

5.2.3 Excavation

The primarly area to be excavated is shown in **Figure 4-1**. At SEAD-63, excavation will proceed to the bottom of the fill, which ranges from 0.6 feet to greater than 8 feet. The total soil and debris volume to be excavated is approximately 4500 CY.

Sediment will be excavated from the drainage ditches associated with the anomalous sampling locations (SWSD63-3, SWSD63-10, SWSD63-11, SWSD63-14, SWSD63-18, SWSD63-19, and SWSD63-4). The excavation will be to a depth of depth of 6 inches, extending to the width of the drainage (up to 6 feet) and 25 feet up- and down-gradient from each location. Where two sediment locations are adjacent, the excavation will be continuous between the locations.

Excavation of materials will be limited to daylight hours. The rate of excavation will greatly exceed the segregation rate so debris and soil will be stockpiled. The area to be excavated will be de-watered prior to the excavation, but if necessary, a pump will be used to remove water from the pit. This water will be pumped into frac tanks, where it will be treated along with the remainder of the water. In order to minimize emissions, dust control foams and other housekeeping measures may be used in the area with the highest concentrations of contaminants. During the excavation, the walls of the excavation will be sloped to assure their stability, in accordance with the levels required by OSHA. Alternate techniques may also be used to provide excavation stability.

5.2.4 Material Screening Operations

Once the material is excavated, it will need to be segregated prior to disposal. A staging area, including separate areas for the storage of excavated soil, contaminated and non-contaminated screened soil, and contaminated and non-contaminated debris will be set up. A separate area will be established for required equipment decontamination operations. Debris will be screened for radioactivity and to check for potential classified items. Soil will also be screened for radioactivity.

5.2.5 Off-Site Disposal

Although soil having constituents above clean up goals (see **Table 3-1**) is not anticipated, any such soils plus all debris will be disposed off-site according to the conceptual plan in **Figure 4-2**. If radionuclides are present in the soil above background concentrations, derived concentration guideline levels (DCGLs) will require finalization as discussed in **Section 3.3.2**. The proposed facility for disposal of radiological debris and soil is Envirocare located in Clive, UT. A copy of their license describing their acceptance criteria is provided in **Appendix H**.

5.2.6 Backfill, Site Restoration, and Demobilization

Soils from the excavation will be backfilled into the excavation pit once sampling confirms that all impacted soils have been removed and soils from the excavation do not exceed clean up goals. The excavated areas will be filled with borrow and restored to the original grade. Clean fill will be brought in as necessary to make up for the debris taken from SEAD-63 to off-site facilities. The area will then be re-seeded with native vegetation. The contractor will be responsible for maintaining the area for enough time for this vegetation to become established.

All of the equipment used by the contractor will be decontaminated prior to leaving the site. Decontamination water will be collected and properly treated (if necessary) and disposed.

5.2.7 Air Monitoring

There are sources of air emissions: the excavation and screening activities. The program will be designed to ensure compliance with all air ARARs. Air emissions of potential concern include airborne dust or particulate and fugitive organic compounds.

Potential emissions of particulate matter from the excavation and screening operations will be monitored in accordance with the provisions of NYSDEC TAGM HWR-89-4031. Sampling stations for particulate matter will be set up daily, at the point where fugitive particulate emissions are most likely to occur (e.g., downwind of locations of the current excavation and near screening locations), and at a location upwind of the site work which will be representative of background.

The MINIRAM (Miniature Real-time Aerosol Monitor manufactured by Monitoring Instruments for the Environment, Inc.) personal monitor model PDM-3 or equivalent will be used for ambient measurements at all locations. The operating principle of the MINIRAM is based on the detection of scattered electromagnetic radiation in the near infrared region of the spectrum. The MINIRAM detects both aerosols and particulate matter, preferentially in the 0.1 to 10 micron range (respirable or inhalable size). Air surrounding the instrument passes freely through the sensing chamber, requiring no pump for operation. The average concentration of the particulate and aerosol level is recorded every 10 seconds The instrument can also calculate a time weighted average for the run on a continuous basis with all results reported in units of milligrams per cubic meter (mg/m^3).

During set-up, each monitor will be placed 4 to 6 feet above ground. The actual placement of the sampling stations will be modified daily to accommodate shifts in the ambient winds, and the actual locations will be recorded in the field notes. After set-up, each instrument will be turned on at least 10 minutes and the device will be zeroed in accordance with manufacturer's specifications. Ambient monitoring will then commence at least 10 minutes prior to the introduction of soil feed to the APE 1236, and will continue until all treated soil has been discharged from the rotary kiln. Throughout this period, data will be obtained and recorded at 10-second intervals.

All of the data produced by the MINIRAM will be included in the performance test report. Data collected by the MINIRAM will be compared to the national primary and secondary 24-hour ambient air quality standard of 150 ug/m^3.

Fugitive organic emissions will be monitored in accordance with provisions of the NYSDEC Community Air Monitoring Plan, which specifies action levels at a distance of 200 feet from the removal action, and at the nearest residence. A monitoring station will be established at a distance of 200 feet from the operations. If the level of organics in the air reaches 5 ppm at the monitoring station, then monitoring must be conducted at the nearest residence. For this removal action, the depot fenceline will be used instead of the nearest residence, since this is much closer to the operations, and will therefore be more protective of the community. If unacceptable concentrations of target organics are detected at the fenceline, work will be shut down until this situation has been investigation and further controls are implemented to prevent the reoccurrence of this condition.

5.2.8 Installation of New Monitoring Wells

Up to four new monitoring wells will be installed near SEAD-63 and samples of the groundwater will be collected from new wells plus from existing wells to further define the nature of the groundwater found in the area. New samples from existing and new wells will be collected using low-flow, purge-and-pump procedures to minimize turbidity levels. Data from the resampling event will be used to assess whether there is continuing evidence of metal and radiological component impact on the groundwater quality in the area.

5.2.9 Site Health and Safety

The contractor will be responsible for complete compliance with all OSHA and EPA regulations for operations at hazardous waste sites. All workers will have received the mandatory training, and be part of a medical monitoring program. The contractor will prepare and follow a site-specific health and safety plan that will be approved by the Army prior to the start of work. The health and safety plan will contain procedures for dealing with site visitors, including those visitors who have not received proper training. People not receiving proper training may be allowed on site, but will not be allowed in the work area.

5.2.10 Oversight

A third party contractor will be hired to provide oversight for the removal action activities. This contractor will prepare a construction quality assurance (CQA) plan and will document the procedures to be followed to ensure that the removal action meets the established specifications. CQA duties will include, but not be limited to the following activities:

- Confirmation sampling and analysis from the excavation, and
- Air monitoring

It is anticipated that an oversight contractor will be onsite for the duration of the removal action.

5.3 PROPOSED SCHEDULE

The total duration for the removal action after regulatory approval is 2 months.

5.4 ESTIMATED COST

The estimated present worth cost of $1,090,000 is based upon a preliminary estimate provided by Parsons Engineering Science, using the TRACES/MCACES for Windows v1.2 software.

6.0 PUBLIC COMMENT

According to the NCP (section 300.415 [m][4]), where a removal action is appropriate at a site and where a planning period of at least 6 months exists prior to initiation of site activities, the lead agency (i.e., the Army) must publish a notice of availability and a brief description of the EE/CA. The public will then have an opportunity for not less than 30 calendar days to submit written and oral comments on the EE/CA to the Army. A public meeting could be held, if requested. The NCP also states that a written response to significant comments must be produced after the public comment period (i.e., the responsiveness summary and the action memorandum). Once the action memorandum and the responsiveness summary have been prepared, the removal action is initiated.

7.0 REFERENCES

Eisenbud, M. and Gesell, T. 1997. Environmental Radioactivity From Natural, Industrial, and Military Sources. 4th Edition. Academic Press, San Diego, CA.

Gilbert, 1987. Statistical Methods for Environmental Pollution Monitoring.

Lasala, A.M., Jr., 1968. Groundwater Resources of the Erie-Niagra Basin, New York. basic Planning Report ENB-3, State of New York Conservation Department with Resources Commission.

Martin and Johnson, 1989. Hazardous Waste Management Engineering. Edward J. Martin, and James H. Johnson, Jr., editors. New York: Van Nostrand Reinhold Company.

Mazola, A.J., 1951. The Groundwater Resources of Seneca County, New York Bulletin GW-26. Water, Power, and Control Commission, Department of Conservation, State of New York, Albany, New York.

Michel, R. L. and Kraemer, F. 1995. Journal of Hydrology. Vol. 164. pp. 1-18

Muller, E.H., and Cadwell, D.H., 1986. Surficial Geologic Map of New York State Finger Lakes Sheet. Survey, Map, and Chart Series No. 40.

Multi-Agency Radiological Site and Survey Investigation Manual. (MARSSIM, NUREG-1575, EPA 402-R-97-016) December 1997.

New York State Department of Environmental Protection (NYSDEC), Division of Hazardous Waste Remediation, Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, January 24, 1994.

NYSDEC, Division of Fish, Wildlife and Marine Resources, Technical Guidance for Screening Contaminated Sediments, January 1999.

NYSDEC, Division of Water Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, Reissue Date June 1998.

New York State Department of Environmental Conservation (NYSDEC), 1989a, Clean-up Criteria for Aquatic Sediments, Department of Environmental Conservation, Albany, New York.

New York State, Division Technical and Administrative Guidance Memorandum (TAGM): Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites; October 1994.

Parsons Engineering Science, Inc., Expanded Site Inspection Report for Seven Low Priority SWMUs, April 1995.

Parsons Engineering Science, Inc., Generic Installation RI/FS Workplan, June, 1995.

Sims, 1990. "Soil Remediation Techniques at Uncontrolled Hazardous Waste Sites, a Critical Review," by Ronald C. Sims. Journal of the Air and Waste Management Association, (May 1990) 703-732.

SCS, 1972. Soil Survey of Seneca County, New York. U.S. Department of Agricultural, Soil Conservation Service.

Todd, D.K., 1976. Groundwater Hydrology. John Wiley and Sons, New York.

EPA, 1986. Handbook for Stabilization/Solidification of Hazardous Waste. EPA/540/2-86/001. Washington, D.C.: U.S. Environmental Protection Agency.

EPA, 1988a. Technology Screening Guide for Treatment of CERCLA Soils and Sludges. EPA/540/2-88/004. Washington, D.C.: U.S. Environmental Protection Agency.

EPA, 1988b. Experience in Incineration Applicable to Superfund Site Remediation. EPA/625/9-88/008. Washington, D.C.: U.S. Environmental Protection Agency.

EPA, 1988c. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. EPA/540/G-89/004. Washington, D.C. U.S. Environmental Protection Agency.

EPA, 1989a. Stabilization/Solidification of CERCLA and RCRA Wastes. EPA/625/6-89/022. Washington, D.C.: U.S. Environmental Protection Agency.

EPA. 1989b. Bioremediation of Contaminated Surface Soils. EPA/600/9-89/073. Washington. D.C.: U.S. Environmental Protection Agency.

EPA. 1989c. Terra Vac In Situ Vacuum Extraction System. Applications Analysis Report. EPA/540/A5-89/003. Washington. D.C.: U.S. Environmental Protection Agency.

EPA. 1990. Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils. EPA/540/2-90/002. Washington. D.C.: U.S. Environmental Protection Agency.

EPA. 1999. Risk Assessment Guidance For Superfund. Volume I: Human Health Evaluation Manual. Supplemental Guidance: Dermal Risk Assessment. Interim Guidance. Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington. D.C. 20460.

United States Army Toxic and Hazardous Materials Agency (USATHAMA). 1989. Seneca Army Depot Landfill/Burning Pit Site Investigation.

APPENDIX B

SEAD-63 TEST PIT LOGS
SEAD-63 WELL COMPLETION REPORTS
SEAD-63 BORING LOGS
SEAD-63 WELL DEVELOPMENT REPORTS

SEAD-63 TEST PIT LOGS

TEST PIT REPORT

ENGINEERING—SCIENCE, INC.	**CLIENT:** USACOE	**TEST PIT #:** TP63-1

PROJECT: 15 SWMU ESI
LOCATION: Romulus N.Y.

JOB NUMBER: 720518
EST. GROUND ELEV.:
INSPECTOR: JWC/ABS
CONTRACTOR: ES/ESI
START DATE: 6/25/94
COMPLETION DATE: 6/25/94
CHECKED BY:
DATE CHECKED:

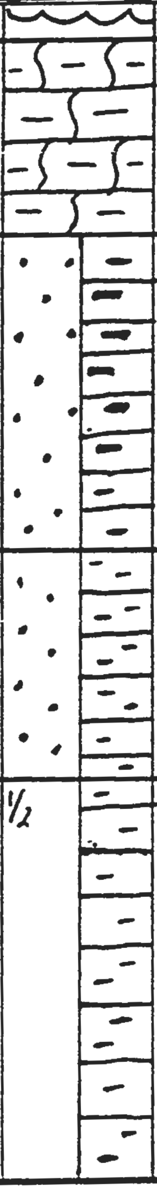
TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
20'	4.5'	8'	BACKHOE

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM 580B	10.0eV	0ppm	1400h 6/25/94
Victoreen-190	Pancake	10-15µR/hr	1400h 6/25/94
Ludlum 19µR	NaI	8-13µR/hr	1400h 6/25/94
Ludlum 2221	α Scint.	6 CPM	1400h 6/25/94
Eberline RAP-1	Filter	——	1400h To 1600h 6/25/94

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number:
MRD Sample Number:
QA/QC Rinsate Sample Number:
COMMENTS: Visitor: Kamal Gupta.



SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				TOPSOIL	
1	0ppm BKGD				2" Shale Gravel	
2	0ppm BKGD				1'0" Olive Gray SilT (one Half) Shale Gravel (one Half)	1' To 2': HAlf The width of The piT was Shale Gravel 2' To 8': was miscellaneous
3	0ppm BKGD	TP63-1	3'		2'4" Light Brown SilT (one Half) Shale Gravel (one HAlf) WITh	components over 1/2 The width of The piT. Components
4 5	0ppm BKGD	BASe of This ½ of The piT			3'4" Miscellaneous Components	Included: Battery Assemblies, Accelerometers, Lock mechanisms, Fire/SAFE pins, BARO switchs

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS   TEST PIT #: TP63-1

PAGE 2 OF 2

TEST PIT REPORT

ENGINEERING-SCIENCE, INC. | **CLIENT:**

TEST PIT #: TP63-1

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE

DATE START:
DATE FINISH:
INSPECTOR: JWC/AS
CONTRACTOR:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6						
7						
8						
					8' BASE OF PIT	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP6..

PAGE 1 OF 2

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	CLIENT: USACOE	TEST PIT #: TP63-2

PROJECT: 15 SWMU ESI
LOCATION: ROMULUS, NY

JOB NUMBER: 72051
EST. GROUND ELEV.
INSPECTOR: JWC/ABS
CONTRACTOR: ES/ESI
START DATE: 6/26/94
COMPLETION DATE: 6/26/94
CHECKED BY:
DATE CHECKED:

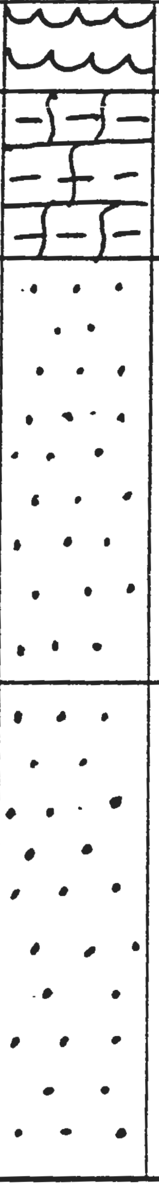
TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
3'	3'	5' 6"	BACKHOE

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM - 580B	10.0 eV	0 PPM	0836h / 6 / 26 / 94
VICTOREEN - 190	pancake	8 - 12 µR/hr	0836h / 6 / 26 / 94
LUDLUM 2221 w/ SCALER	α Scint.	5 cpm	0836h / 6 / 26 / 94
LUDLUM 19 µR	γ-NaI	9 - 12 µR/hr	0836h / 6 / 26 / 94

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number:
MRD Sample Number:
QA/QC Rinsate Sample Number:
COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				Top Soil	
1	0ppm BKGD				4" Shale gravel	
2	0ppm BKGD	TP63-2	2'		1' 1" Olive Gray SilT	
3 4 5	0ppm BKGD				2' 11" Light Brown SilT 5' : ∇ water TABLE	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS TEST PIT #: TP63-2

TEST PIT REPORT

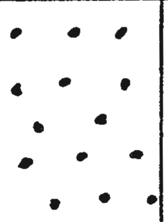
ENGINEERING–SCIENCE, INC.	CLIENT:	TEST. PIT #TP63-2

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/ DATE

DATE START:
DATE FINISH:

INSPECTOR: JWC/AS
CONTRACTOR:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6						
					5'6" BASE OF PIT	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-2

TEST PIT REPORT

ENGINEERING–SCIENCE, INC.	CLIENT: USACOE	TEST PIT #: TP63-3

PROJECT: 15 SWMU ESI
LOCATION: ROMULUS, NY

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JWC/ABS
CONTRACTOR: ES/ESI
START DATE: 6/26/94
COMPLETION DATE: 6/26/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
13'	8'	9.2	BACKHOE

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.0 eV	0 PPM	0935h / 6/26/94
VICTOREEN-190	pancake	10-15 μR/hr	0935h / 6/26/94
LUDLUM 2221 w/ SCALER	α Scint.	2-5 cpm	0935h / 6/26/94
LUDLUM 19 μR	γ-NaI	10-15 μR/hr	0935h / 6/26/94

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number:
MRD Sample Number:

QA/QC Rinsate Sample Number:

COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				Topsoil	
1	0ppm BKGD				.3' Shale GRAVEL with dark Gray SiLT.	
2						
3						
4						
5	0pm- BKGD	0			4.2' Miscellaneous Components	Anomalies: BATTery Assemblies, accelerometers, Cannon Connectors Lock Mechanisms, etc

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS   TEST PIT #: TP63-3

TEST PIT REPORT

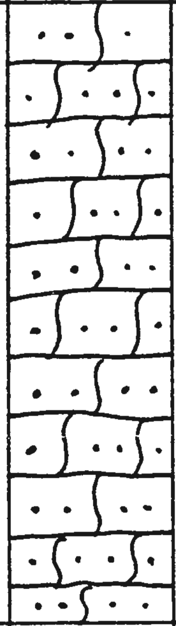
ENGINEERING–SCIENCE, INC.	CLIENT:	TEST. PIT #: TP63-3

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE

DATE START:
DATE FINISH:

INSPECTOR: JWC/ABS
CONTRACTOR:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6					∇ WATER @ 6.0'	
		TP63-3	6.5'			
7	0 ppm BKGD				6.5' Dark Gray SILT with shale clasts	
8						
9						
					9.2' Base of PiT	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-3

PAGE 1 OF 2

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	CLIENT:	TEST PIT #: TP63-4

PROJECT: 15 SWMU INVESTIGATION
LOCATION: SEAD 63 TEST PIT #4

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JWC/AS
CONTRACTOR: ES
START DATE: 6/26/94
COMPLETION DATE: 6/26/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
12'	3'	6.5'	BACKHOE

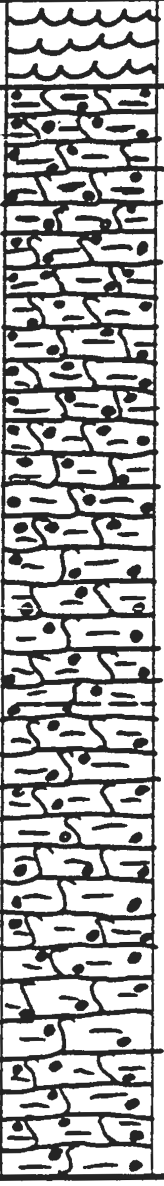
MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.6 eV	0 ppm	1330h 6/26/94
VICTOREEN-190	6m Probe	8-12 µR/hr	1330h 6/26/94
LUDLUM 2221 w/43-5	α Scint.	1-3 cpm	1330h 6/26/94
LUDLUM micro-R	γ NAI	8-12 µR/hr	1330h 6/26/94
EBERLINE RAP-1	Filter		

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number: N/A
MRD Sample Number: N/A

QA/QC Rinsate Sample Number:

COMMENTS:



SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				TOPSOIL	0-4"
1	0ppm BKGD				SHALE /GRAVEL LAYER w/DARK SHALE w/ DARK GRAYSILT	Anomalies: Quick Connects, Battery Assem'ly, Baroswitch, Lock mechanisms, other.
2						4"-60"
3		TP63-4-1	3'			
4						
5					⊻ WATER TABLE @5'	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS TEST PIT #: TP63-4

PAGE 2 OF 2

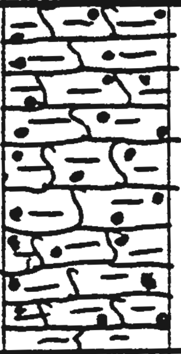
TEST PIT REPORT

ENGINEERING–SCIENCE, INC. | **CLIENT:** SEAD | **TEST PIT #:** TP63-4

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
SAME AS ABOVE			

DATE START: 6/26/94
DATE FINISH: 6/26/94
INSPECTOR: JWC/AS
CONTRACTOR: ES/EMPIRE

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6					SHALE /GRAVEL LAYER W/ DARK SHALE W/DARK GRAY SILT BOTTOM OF TEST PIT @ 6'5"	60-77
7						

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS | TEST PIT #: TP63

G:\123DATA\FIELDFMS\TSTPITP2.WK3

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	CLIENT: SEAD	TEST PIT #: TP63-5

PROJECT: 15 SWMU INVESTIGATION
LOCATION: SEAD 63 TEST PIT #5

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JWC/AS
CONTRACTOR: ES/EMPR
START DATE: 6/26/94
COMPLETION DATE: 6/26/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
17'	3'	5'	BACKHOE

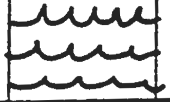
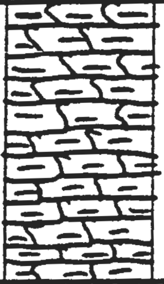
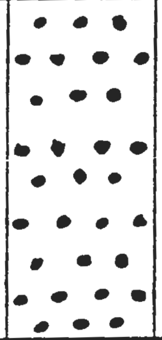
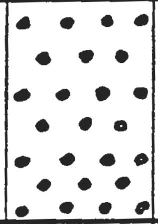
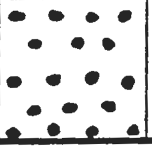
MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.6 eV	0 PPm	6/26/94
VICTOREEN-190	Gm-Probe	8-12 µR/hr	6/26/94
LUDLUM 2221 W/43-5	α Scint.	1-3 CPm	6/26/94
LUDLUM mICRO-R	γ NAI	8-12 µR/hr	6/26/94
EBERLINE · RAP-1	Filter		6/26/94

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number: N/A
MRD Sample Number: N/A

QA/QC Rinsate Sample Number:

COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				TOPSOIL	0-6"
1	0ppm BKGD				SHALE/GRAVEL	6"-21"
2	0ppm	TP63-5-1	2'			
3	BKGD				OLIVE GRAY SILT	21"-41"
4	0ppm BKGD				LIGHT BROWN SILT	41"-53"
5	0ppm BKGD				LIGHT BROWN SILT BOTTOM OF TEST PIT @ 5'	55"-60"

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS TEST PIT #:

PAGE 1 OF 2

TEST PIT REPORT

ENGINEERING–SCIENCE, INC.	CLIENT: SEAD	TEST PIT #: TP63-6

PROJECT: 15 SWMU INVESTIGATION
LOCATION: SEAD 63

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JNC/
CONTRACTOR: ES/
START DATE: 6/27/94
COMPLETION DATE: 6/27/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
39'	3'	8'	BACKHOE

MONITORING DATA

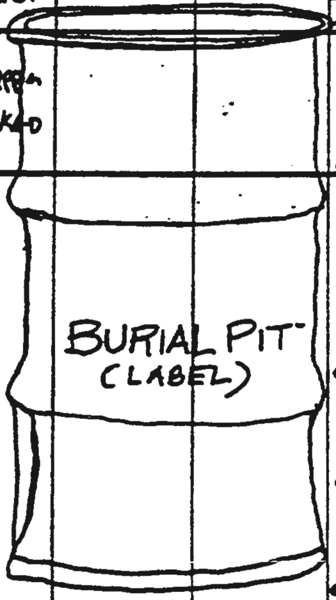
INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.6eV	0 ppm	6/27/94
VICTOREEN-190	GM-Probe	8-12 uR/hr	6/27/94
LUDLUM 2221 w/43-5	α SCINT.	1-3 cpm	6/27/94
LUDLUM micro-R	γ NAI	8-12 uR/hr	6/27/94
EBERLINE RAP-1	Filter		6/27/94

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number: N/A
MRD Sample Number: N/A

QA/QC Rinsate Sample Number:

COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				TOPSOIL	0"-4"
1	0ppm BKGD				LIGHT BROWN SILT (very stiff) SHALE DEPOSITS	4"-12"
2 3	0ppm BKGD	TP63-6-1	3'		LIGHT GRAY SILT	12"-45"
4 5	0ppm BKGD				OLIVE GRAY SILT	45"-60"



SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS TEST PIT #: TP6

TEST PIT REPORT

ENGINEERING-SCIENCE, INC. **CLIENT:** SEAD **TEST PIT #:** TP63-6

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
SAME AS ABOVE			

DATE START: 6/27/94
DATE FINISH: 6/27/94
INSPECTOR: JWC/AS
CONTRACTOR: ES/EMPIRE

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6 7				● ● ● ●	OLIVE GRAY SILT	60"-92"
8				● ● ● ●	BOTTOM OF TEST PIT #6	92"-96"
9 10						

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-6

TEST PIT REPORT

ENGINEERING–SCIENCE, INC.	CLIENT: SEAD	TEST PIT #: TP63-7

PROJECT: 15 SWMU INVESTIGATION
LOCATION: SEAD 63 TEST PIT #7

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JWC
CONTRACTOR: ES/E
START DATE: 6/27/94
COMPLETION DATE: 6/27/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
11'	10'	8'	BACKHOE

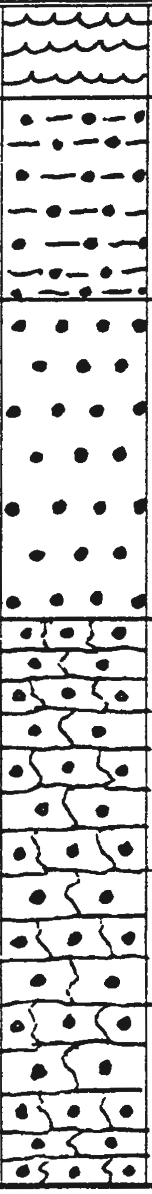
MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.6eV	0 ppm	6/27/94 (1120)
VICTOREEN-190	GM-Probe	8-12 µR/hr	6/27/94 (1120)
LUDLUM 2221 w/43-5	α SCINT.	1-3 cpm	6/27/94 (1120)
LUDLUM MKRG-R	γ NAI	8-12 µR/hr	6/27/94 (1120)
EBERLINE RAP-1	filter		6/27/94 (1120)

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number: N/A
MRD Sample Number: N/A

QA/QC Rinsate Sample Number: N/A

COMMENTS:



SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				TOPSOIL	0-4"
1	0ppm BKGD				LIGHT GRAY GRAVEL & SILT	4"-15"
2	0ppm BKGD	TP63-7-1	1.5'		LIGHT BROWN SILT	*WIRING, QUICK CONNECTS, CRUSHED DRU 15"-31"
3 4 5	0ppm BKGD				OLIVE GRAY SILT w/SHALE DEPOSITS	31"-60"

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS TEST PIT #: TP 7

TEST PIT REPORT

ENGINEERING-SCIENCE, INC. **CLIENT:** SEAD

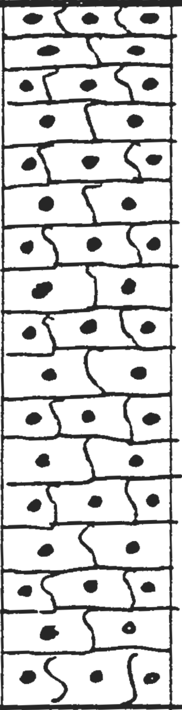
TEST PIT #: TP63-7

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
SAME AS ABOVE			

DATE START: 6/27/94
DATE FINISH: 6/27/94

INSPECTOR: JWC/AS
CONTRACTOR: ES/EMPIRE

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6					OLIVE GRAY SILT w/SHALE DEPOSITS	60"-96"
7						
8					BOTTOM OF TEST PIT #7	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-7

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	CLIENT: SEAD	TEST PIT #: TP63-8

PROJECT: 15 SWMU INVESTIGATION
LOCATION: SEAD 63 TEST PIT #8

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JWC/
CONTRACTOR: ES/L
START DATE: 6/27/94
COMPLETION DATE: 6/27/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
13'3"	3'	5'3"	BACK HOE

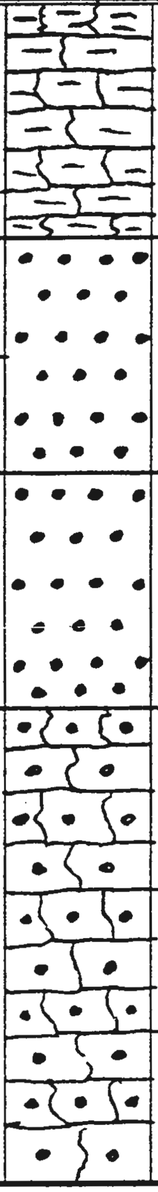
MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.6 eV	0 PPM	6/27/94 (1350)
VICTOREEN-190	GM-PROBE	8-12 µR/hr	6/27/94 (1350)
LUDLUM 2221 w/43-5	α SCINT.	1-3 CPM	6/27/94 (1350)
LUDLUM MICRO-R	γ NAI	8-12 µR/hr	6/27/94 (1350)
EBERLINE RAP-1	filter		6/27/94 (1350)

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number: N/A
MRD Sample Number: N/A

QA/QC Rinsate Sample Number: N/A

COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
1	0ppm BKGD				SHALE/GRAVEL	0-12"
2	0ppm BKGD	TP63-8-1	1.5'		Yellow-ORANGE SILT	12"-24"
3	0ppm BKGD				LIGHT BROWN SILT	24"-36"
4 5	0ppm BKGD				OLIVE GRAY SILT w/SHALE DEPOSITS	36"-60"

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS TEST PIT #: TP63-8

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	**CLIENT:** SEAD	**TEST PIT #:** TP63-8

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/ DATE
SAME AS ABOVE			

DATE START: 6/27/94
DATE FINISH: 6/27/94
INSPECTOR: JWC/AS
CONTRACTOR: ES/EMPIRE

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
					WATER TABLE ∇ @ 5'3"	
					BOTTOM OF TEST PIT #8	
6						

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-8

PAGE 1 OF 2

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	**CLIENT:** SEAD	**TEST PIT #:** TP63-9

PROJECT: 15 SWMU INVESTIGATION
LOCATION: SEAD 63 TEST PIT #9

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JWC/AS
CONTRACTOR: ES/EM.
START DATE: 6/27/94
COMPLETION DATE: 6/27/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
14.5'	3'	8'2"	BACKHOE

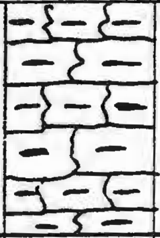
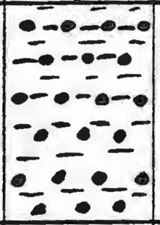
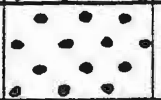
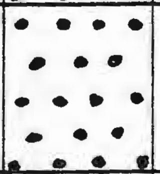
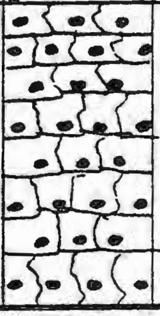
MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/ DATE
OVM-580B	10.6 eV	0 ppm	6/27/94 (1455)
VICTOREEN 190	GM-Probe	8-12 uR/hr	6/27/94 (1455)
LUDLUM 2221 w/43-5	α SCINT.	1-3 CPM	6/27/94 (1455)
LUDLUM MIKRO-R	γ NAI	8-12 uR/hr	6/27/94 (1455)
EBERLINE RAP-1	filter		6/27/94 (1455)

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number: N/A
MRD Sample Number: N/A

QA/QC Rinsate Sample Number: N/A

COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
1	0 ppm BKGD				SHALE/GRAVEL	0-12"
2	0 ppm BKGD				LIGHT BROWN SILT w/SOME GRAVEL	12"-23"
	0 ppm BKGD	TP63-9	2.5'		OLIVE GRAY SILT	23"-32" BASE OF FILL
3	0 ppm BKGD				LIGHT BROWN SILT (W/ORGANIC MATTER 32"-34")	32"-36"
	0 ppm BKGD				DARK GRAY SILT	36"-45"
4 5	0 ppm BKGD				OLIVE GRAY SILT (w/SHALE DEPOSITS)	45"-60"

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS   TEST PIT #: TP6 9

PAGE 2 OF 2

TEST PIT REPORT

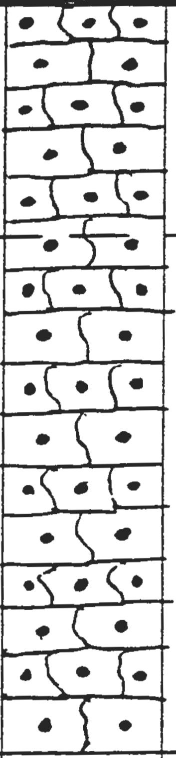
ENGINEERING-SCIENCE, INC.	CLIENT: SEAD	TEST PIT #: TP63-9

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
SAME AS ABOVE			

DATE START: 6/27/94
DATE FINISH: 6/27/94

INSPECTOR: JWC/AS
CONTRACTOR: ES/EMPIRE

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6					∇ WATER TABLE @ 6'	
					OLIVE GRAY SILT w/SHALE DEPOSITS	45-98"
7						
8					BOTTOM OF TEST PIT @ 8'2"	
9						

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-9

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	**CLIENT:** SEAD	**TEST PIT #:** TP63-10

PROJECT: 15 SWMU INVESTIGATION
LOCATION: SEAD 63 TEST PIT #10

JOB NUMBER: 720518
EST. GROUND ELEV.
INSPECTOR: JWC/AS
CONTRACTOR: ES/EMI
START DATE: 6/28/94
COMPLETION DATE: 6/28/94
CHECKED BY:
DATE CHECKED:

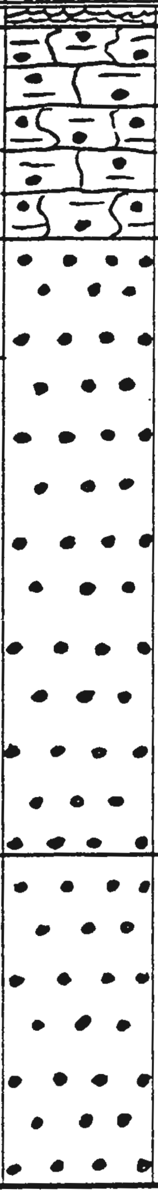
TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
12'	3'	5'4"	BACKHOE

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.6 eV	0 ppm	6/28/94 (0840)
VICTOREEN-190	GM-Probe	8-12 µR/hr	6/28/94 (0840)
LUDLUM 2221 w/43-5	α SCINT.	1-3 CPM	6/28/94 (0840)
LUDLUM MK80-R	γ NAI	8-12 µR/hr	6/28/94 (0840)
EBERLINE RAP-1	filter		6/28/94 (0840)

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number: N/A
MRD Sample Number: N/A
QA/QC Rinsate Sample Number: N/A
COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0 ppm				TOPSOIL / PEAT MOSS	0-1"
1	BKGD 0 ppm BKGD				SHALE/GRAVEL w/SILT	1"-12"
2 3	0 ppm BKGD	TP63-10	1.5'		LIGHT BROWN SILT	12"-44"
4 5	0 ppm BKGD				OLIVE GRAY SILT	44"-60"

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	CLIENT: SEAD	TEST PIT #: TP63-10

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
SAME	AS	ABOVE	

DATE START: 6/28/94
DATE FINISH: 6/28/94

INSPECTOR: JWC/AS
CONTRACTOR: ES/EMPIRE

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
				● ● ● ●	OLIVE GRAY SILT	60"-64"
					BOTTOM OF TEST PIT @ 64"	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-10

PAGE 1 OF 2

TEST PIT REPORT

ENGINEERING-SCIENCE, INC.	CLIENT: USACOE	TEST PIT #: TP63-1

PROJECT: 15 SWMU ESI
LOCATION: ROMULUS, NY

JOB NUMBER: 7205
EST. GROUND ELEV.
INSPECTOR: JWC/ABS
CONTRACTOR: ES/ESI
START DATE: 6/28/94
COMPLETION DATE: 6/28/94
CHECKED BY:
DATE CHECKED:

TEST PIT DATA

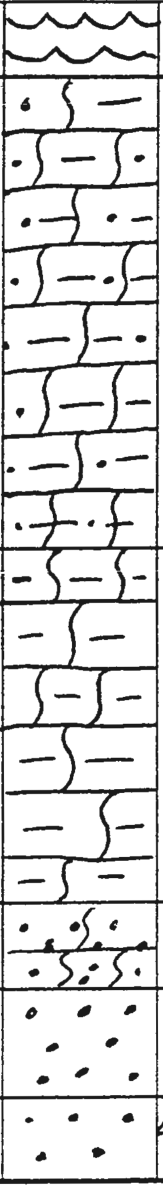
LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
14'	5' 8"	7' 3"	BACKHOE

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.0 eV	0 PPM	0906h / 6/28/94
VICTOREEN-190	pancake	10-15 µR/hr	0906h / 6/28/94
LUDLUM 2221 w/ SCALER	α Scint.	3-5 CPM	0906h / 6/28/94
LUDLUM 19 µR	γ-NaI	10-15 µR/hr	0906h / 6/28/94

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]
Duplicate Sample Number:
MRD Sample Number:
QA/QC Rinsate Sample Number:
COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				Top Soil	
1 2	0ppm BKGD				4" Olive Gray Silt and Shale Gravel with Few miscellaneous components	miscellaneous components Included: Accelerometers, BARO switchs Battery Assem Lock mechanisms.
3	0ppm BKGD	TP63-11	3'		2' 4" DARK Gray Fine Shale Gravel with miscellaneous components	
4	0ppm BKGD				3'10" DARK Olive Gray Silt with Few Shale Clasts	
	0ppm BKGD				4'4" Light Brown Silt	
5	0ppm BKGD				4'9" Olive Gray Silt	



SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS   TEST PIT #: TP63-11

TEST PIT REPORT

ENGINEERING-SCIENCE, INC. **CLIENT:**

TEST PIT #: TP63-11

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE

DATE START:
DATE FINISH:
INSPECTOR: JWC/AS
CONTRACTOR:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
6						
7						
					7'3" BASE OF PIT	
8						

PAGE 1 OF 2

TEST PIT REPORT

ENGINEERING–SCIENCE, INC.

CLIENT: USACOE

TEST PIT #: TP63-12

PROJECT: 15 SWMU ESI

LOCATION: ROMULUS, NY

JOB NUMBER: 7205

EST. GROUND ELEV.

INSPECTOR: JWC/ABS

CONTRACTOR: ES/ESI

START DATE: 6/28/94

COMPLETION DATE: 6/28/94

CHECKED BY:

DATE CHECKED:

TEST PIT DATA

LENGTH	WIDTH	DEPTH	EXCAVATION/SHORING METHOD
			BACKHOE

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE
OVM-580B	10.0 eV	0 PPM	1040h / 6/28/94
VICTOREEN-190	pancake	9-15 µR/hr	1040h / 6/28/94
LUDLUM 2221 w/ SCALER	α ScinT.	1-3 CPM	1040h / 6/28/94
LUDLUM 19 µR	γ-NaI	9-15 µR/hr	1040h / 6/28/94

QA/QC DUPLICATE SAMPLE: YES or [✓ NO]

Duplicate Sample Number:

MRD Sample Number:

QA/QC Rinsate Sample Number:

COMMENTS:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
	0ppm BKGD				TopSoil	
	0ppm BKGD				2" DARK Gray Shale Gravel	
1 2	0ppm BKGD				7" Olive Gray SilT with Few shale clasTs	
3 4 5	0ppm BKGD	TP63-12	5'		2' 8" Olive Gray Silt with Few Shale DeposiTs	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

TEST PIT #: TP63-12

PAGE 2 OF 2

TEST PIT REPORT

ENGINEERING–SCIENCE, INC. | **CLIENT:** | **TEST. PIT #:** TP63-12

MONITORING DATA

INSTRUMENT	DETECTOR	BACKGROUND	TIME/DATE

DATE START:
DATE FINISH:

INSPECTOR: JWC/ABS
CONTRACTOR:

SCALE (FT)	VOC/ RAD.	SAMPLE NUMBER	SAMPLE DEPTH RANGE	STRATA SCHEMATIC	DESCRIPTION OF MATERIALS (BURMEISTER METHODOLOGY)	REMARKS
						
					BASE OF PIT 5' 4"	

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS

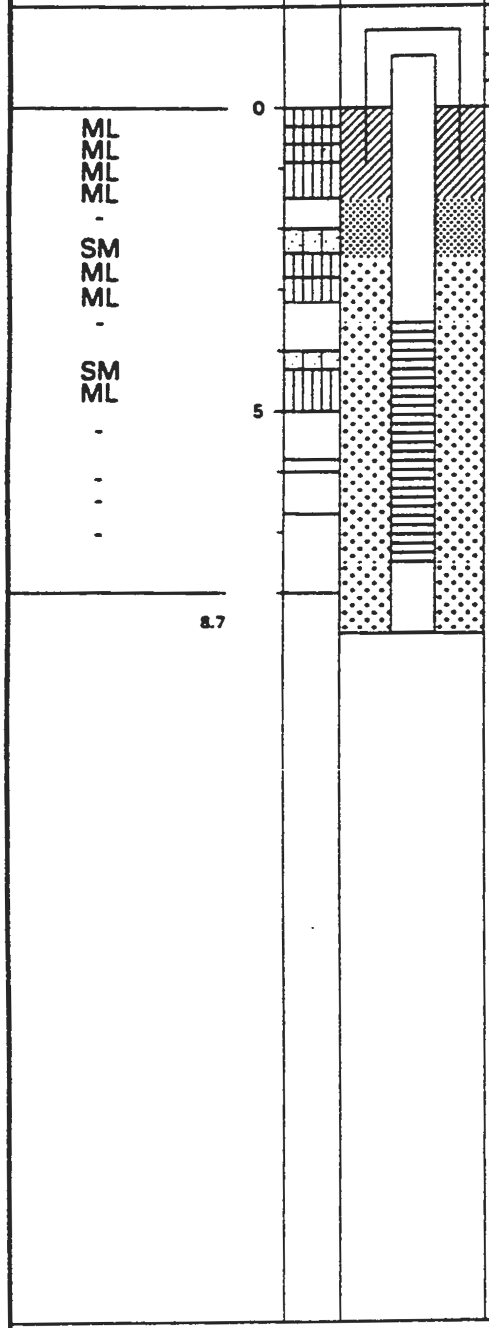
TEST PIT #: TP63-12

SEAD-63 WELL COMPLETION REPORTS

COMPLETION REPORT OF WELL No. MW63-1

PROJECT:	SEVEN LOW PRIORITY AOCs	WELL LOCATION (N/E):	1013124.1 741608.4
PROJECT LOCATION:	SENECA ARMY DEPOT, ROMULUS NY	REFERENCE COORDINATE SYSTEM:	New York State Plane
DRILLING CONTRACTOR:	EMPIRE SOILS INVESTIGATIONS	GROUND SURFACE ELEVATION (ft):	638.3
DRILLING METHOD:	HOLLOW STEM AUGER	DATUM:	NAD 1983
WELL INSTALLATION STARTED:	06/13/94	GEOLOGIST:	K. KELLY
WELL INSTALLATION COMPLETED:	06/13/94	CHECKED BY:	FO

STRATA — MICRO DESCRIPTION (from boring log) — DEPTH (ft) — SYMBOL — WELL DETAILS



DEPTH (ft)		ELEVATION (ft)
	TPC	
	TR	
	TC	
0.0	GS	638.3
1.5	TBS	636.8
2.5	TSP	635.8
3.6	TSC	634.7
7.5	BSC	630.8
8.7	POW	629.6

WELL CONSTRUCTION DETAILS

PROTECTIVE COVER
Diameter: 4
Type: RISER
Interval: 3.5

RISER
Diameter: 2
Type: SCH. 40-PVC
Interval: 4.65

SCREEN
Diameter: 2
Type: SCH. 40-PVC/0.010
Interval: 3.95

SURFACE SEAL
Type: CEMENT
Interval: 1.5

GROUT
Type: N/A
Interval: N/A

SEAL
Type: BENTONITE PELLETS
Interval: 1

SANDPACK
Type: #1, #3 #1: .5' #3: 5.65'
Interval: 6.15

WELL DEVELOPMENT DATA
Date: 6/27/94
Method: BAIL/PUMP
Duration: 2 DAYS
Rate: .220 L/MIN
Final Measurements:

WATER LEVELS

Date	Time	Depth, TR
6/26	1615	5.98
6/27	1255	8.40

pH	Temperature (degrees C)	Conductivity (micromhos/cm)	Turbidity (NTU)
7.19	12.6	390	16

LEGEND

▨	SURFACE SEAL	●	GRAVEL	TPC	TOP OF PROTECTIVE CASING
▩	GROUT	⁘	SAND	TR	TOP OF WELL RISER
▦	SEAL	▥	SILT	GS	GROUND SURFACE
⁙	SANDPACK	▨	CLAY	TBS	TOP BENTONITE SEAL
		☒	NO RECOVERY	TSP	TOP OF SANDPACK
				TSC	TOP OF SCREEN
				BSC	BOTTOM OF SCREEN
				TD	TOTAL DEPTH
				POW	POINT OF WELL

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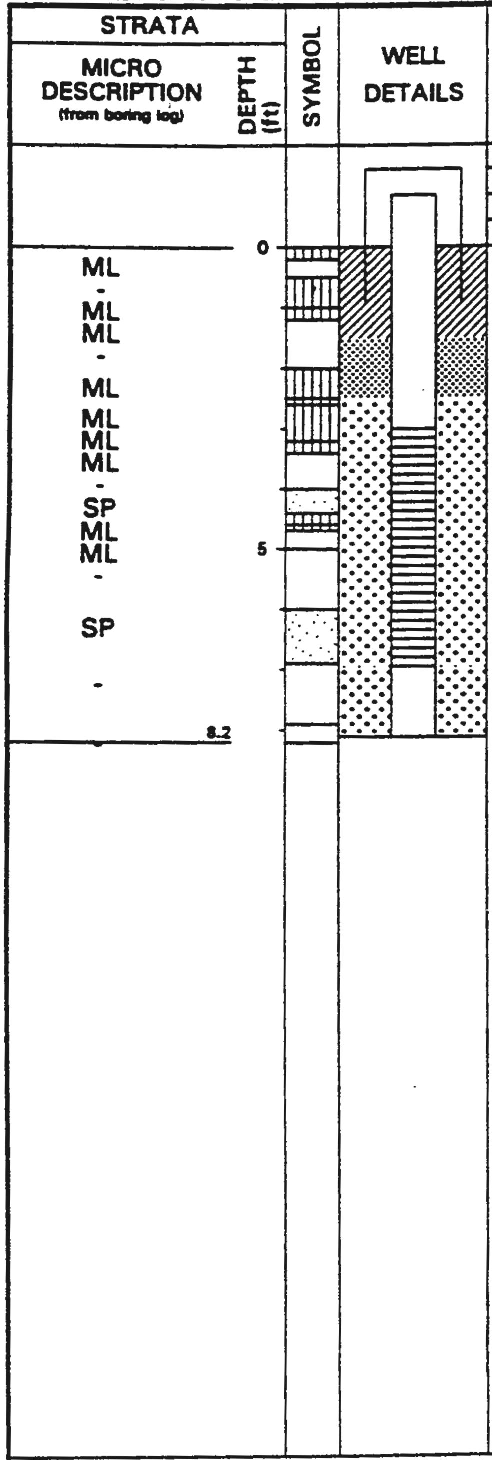
COMPLETION REPORT OF
WELL No. MW63-1

Sheet 1 of 1

COMPLETION REPORT OF WELL No. MW63-2

PROJECT:	SEVEN LOW PRIORITY AOCs	WELL LOCATION (N/E):	1012979.9 741136.2
PROJECT LOCATION:	SENECA ARMY DEPOT, ROMULUS NY	REFERENCE COORDINATE SYSTEM:	New York State Pl
DRILLING CONTRACTOR:	EMPIRE SOILS INVESTIGATIONS	GROUND SURFACE ELEVATION (ft):	630.9
DRILLING METHOD:	HOLLOW STEM AUGER	DATUM:	NAD 1983
WELL INSTALLATION STARTED:	06/14/94	GEOLOGIST:	K. KELLY
WELL INSTALLATION COMPLETED:	06/14/94	CHECKED BY:	FO



DEPTH (ft)		ELEVATION (ft)
	TPC	
	TR	
	TC	
0.0	GS	630.9
1.5	TBS	629.4
2.5	TSP	628.4
3.0	TSC	627.9
7.0	BSC	623.9
8.1	POW	622.8

WELL CONSTRUCTION DETAILS

PROTECTIVE COVER
Diameter: 4
Type: RISER
Interval: 3.5

RISER
Diameter: 2
Type: SCH. 40-PVC
Interval: 4.05

SCREEN
Diameter: 2
Type: SCH. 40-PVC/0.010
Interval: 3.95

SURFACE SEAL
Type: CEMENT
Interval: 1.5

GROUT
Type: N/A
Interval: N/A

SEAL
Type: BENTONITE PELLETS
Interval: 1

SANDPACK
Type: #1, #3
Interval: 5.7 #1: .3" #3: 5.4'

WELL DEVELOPMENT DATA
Date: 6/26/94
Method: BAIL/PUMP
Duration: 2 DAYS
Rate: .893 L/MIN
Final Measurements:

WATER LEVELS

Date	Time	Depth.TR
6/25	1450	2.98
6/26	1410	8.20

pH	Temperature (degrees C)	Conductivity (micromhos/cm)	Turbidity (NTU)
7.02	15.4	600	10

LEGEND

▨	SURFACE SEAL	●	GRAVEL	TPC	TOP OF PROTECTIVE CASING
▩	GROUT	░	SAND	TR	TOP OF WELL RISER
▒	SEAL	▥	SILT	GS	GROUND SURFACE
⁘	SANDPACK	▨	CLAY	TBS	TOP BENTONITE SEAL
		×	NO RECOVERY	TSP	TOP OF SANDPACK
				TSC	TOP OF SCREEN
				BSC	BOTTOM OF SCREEN
				TD	TOTAL DEPTH
				POW	POINT OF WELL

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COMPLETION REPORT OF
WELL No. MW63-2

Sheet 1 of 1

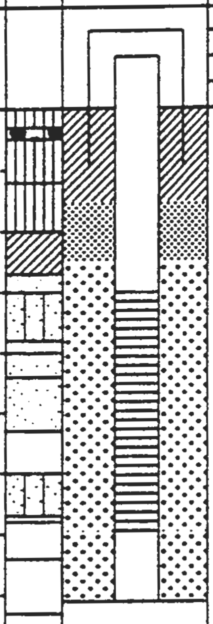
COMPLETION REPORT OF WELL No. MW63-3

PROJECT: SEVEN LOW PRIORITY AOCs
PROJECT LOCATION: SENECA ARMY DEPOT, ROMULUS NY
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS
DRILLING METHOD: HOLLOW STEM AUGER
WELL INSTALLATION STARTED: 06/14/94
WELL INSTALLATION COMPLETED: 06/14/94

WELL LOCATION (N/E): 1013181.9 741130.1
REFERENCE COORDINATE SYSTEM: New York State Plane
GROUND SURFACE ELEVATION (ft): 631.8
DATUM: NAD 1983
GEOLOGIST: K. KELLY
CHECKED BY: FO

STRATA

MICRO DESCRIPTION (from boring log)	DEPTH (ft)
	0
ML	
GM	
ML	
ML	
CL	
SP	
SM	
-	
SP	
SP	5
-	
SM	
-	
-	
-	
	8.3



DEPTH (ft)		ELEVATION (ft)
	TPC	
	TR	
	TC	
0.0	GS	631.8
1.5	TBS	630.3
2.5	TSP	629.3
3.0	TSC	628.8
7.0	BSC	624.8
8.1	POW	623.7

WELL CONSTRUCTION DETAILS

PROTECTIVE COVER
Diameter: 4
Type: RISER
Interval: 3.5

RISER
Diameter: 2
Type: SCH. 40-PVC
Interval: 4.05

SCREEN
Diameter: 2
Type: SCH. 40-PVC/0.010
Interval: 3.95

SURFACE SEAL
Type: CEMENT
Interval: 1.5

GROUT
Type: N/A
Interval: N/A

SEAL
Type: BENTONITE PELLETS
Interval: 1

SANDPACK
Type: #1, #3 #1: .4' #3: 5.4'
Interval: 5.8

WELL DEVELOPMENT DATA
Date: 6/27/94
Method: BAIL/PUMP
Duration: 2 DAYS
Rate: .526 L/MIN
Final Measurements:

WATER LEVELS

	Date	Time	Depth,TR
∇	6/26	1330	4.15
▼	6/26	1610	6.40
▼	6/27	0945	3.42
▼			
∇			
▼			

pH	Temperature (degrees C)	Conductivity (micromhos/cm)	Turbidity (NTU)
6.89	16.1	2000	20

LEGEND

▨	SURFACE SEAL	●	GRAVEL	TPC	TOP OF PROTECTIVE CASING
▩	GROUT	⁘	SAND	TR	TOP OF WELL RISER
▦	SEAL	▥	SILT	GS	GROUND SURFACE
⁙	SANDPACK	▨	CLAY	TBS	TOP BENTONITE SEAL
		☒	NO RECOVERY	TSP	TOP OF SANDPACK
				TSC	TOP OF SCREEN
				BSC	BOTTOM OF SCREEN
				TD	TOTAL DEPTH
				POW	POINT OF WELL

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COMPLETION REPORT OF
WELL No. MW63-3
Sheet 1 of 1

SEAD-63 BORING LOGS

Sheet 1 of 1

LOG OF BORING NO. MW63-1

PROJECT: SEVEN LOW PRIORITY AOCs
PROJECT LOCATION: SENECA ARMY DEPOT, ROMULUS NY
ASSOCIATED UNIT/AREA: SEAD-63
PROJECT NO: 720518-01000
DATE STARTED: 06/13/94
DATE COMPLETED: 06/13/94
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS
DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: 2" SPLIT SPOONS

DEPTH TO WATER (ft): 4.3
BORING LOCATION (N/E): 1013124.1 741608.4
REFERENCE COORDINATE SYSTEM: New York State Plane
GROUND SURFACE ELEVATION (ft): 638.3
DATUM: NAD 1983
INSPECTOR: KK
CHECKED BY: FO

This log is part of the report prepared by Engineering-Science, Inc. for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations.

Sample Number	Blow Counts (# Blows per 6")	Sample Advance (ft)	Sample Recovery (ft)	VOC Screen-PID (ppm)	Rad Screen (cps)	Depth (ft)	Macro Lithology	DESCRIPTION	USCS
.01	3 5 5 5	2.00	1.5	0	BGD	0.3	▨	Gray-brown SILT, some very fine Sand, some organics, loose, dry.	ML
						0.6	▨	AA, no organics, medium stiff.	ML
						0.9	▨	Pink-brown SILT, little very fine Sand, trace(-) organics, medium stiff, dry.	ML
						1 1.5	▨	Brown, very fine SAND + SILT, trace Clay, trace(+) organics, trace fine gray weathered Shale fragments, medium stiff, moist.	ML
						2.0		No Recovery	-
.02	6 8 10 14	2.00	1.2	0	BGD	2 2.4	▨	Brown very fine SAND, some Silt, trace fine Shale fragments, little weathered Shale fragments, moist to wet.	SM
						2.8	▨	Brown SILT, some very fine Sand, trace weathered Shale fragments, moist.	ML
						3 3.2	▨	AA, little(+) weathered Shale.	ML
						4.0		No Recovery	-
.03	5 9 27 72	2.00	1.8	0	BGD	4 4.3	▨	Light brown very fine SAND, some Silt, trace weathered Shale fragments and trace fine Shale fragments.	SM
						5.0	▨	Weathered SHALE, some Silt and very fine Sand, medium stiff, wet to saturated.	ML
						5 5.8	▤	Highly weathered SHALE, moist.	-
						6.0		No Recovery	-
.04	93 100/.2	0.70	0.7	0	BGD	6 6.7	▤	Highly weathered SHALE, dry.	-
						7 8		No Recovery	-

BORING TERMINATED AT 8'
AUGER REFUSAL

NOTES: Bottom of overburden at 5'. No samples were collected for chemical analysis.

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LOG OF BORING MW63-1

Sheet 1 of 1

Sheet 1 of 1

LOG OF BORING NO. MW63-2

PROJECT:	SEVEN LOW PRIORITY AOCs	DEPTH TO WATER (ft):	4.0
PROJECT LOCATION:	SENECA ARMY DEPOT, ROMULUS NY	BORING LOCATION (N/E):	1012979.9 741136.2
ASSOCIATED UNIT/AREA:	SEAD-63	REFERENCE COORDINATE SYSTEM:	New York State Plane
PROJECT NO:	720518-01000	GROUND SURFACE ELEVATION (ft):	630.9
DATE STARTED:	06/14/94	DATUM:	NAD 1983
DATE COMPLETED:	06/14/94	INSPECTOR:	KK
DRILLING CONTRACTOR:	EMPIRE SOILS INVESTIGATIONS	CHECKED BY:	FO
DRILLING METHOD:	HOLLOW STEM AUGER		
SAMPLING METHOD:	2" SPLIT SPOONS		

This log is part of the report prepared by Engineering-Science, Inc. for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations.

Sample Number	Blow Counts (# Blows per 6")	Sample Advance (ft)	Sample Recovery (ft)	VOC Screen-PID (ppm)	Rad Screen (cps)	Depth (ft)	Macro Lithology	DESCRIPTION	USCS
.01	3 4 4 5	2.00	1.2	0	BGD	0.2 0.5		Dark brown SILT + very fine SAND, some organics, trace very fine gray Shale fragments, loose, moist to wet.	ML -
								Gray fractured, weathered SHALE, dry.	ML
						1.0 1 1.2		Light brown SILT and very fine SAND, trace iron-stained Clay, little very fine to fine gray Shale fragments, trace medium gray Shale fragments, medium stiff, moist.	ML -
								Light brown SILT, trace Clay, soft to medium stiff, moist. Iron stained.	
						2.0		No Recovery	
.02	6 8 8 7	2.00	1.4	0	BGD	2 2.5		Light brown and olive gray SILT + CLAY, trace fine weathered Shale fragments, medium stiff, moist.	ML
						2.6		AA, some iron staining.	ML
						3 3.2 3.4		Olive gray SILT + CLAY, some fine to medium weathered gray Shale fragments, medium stiff, moist, trace wetness on Shale fragments. Some iron staining.	ML ML
								Olive gray SILT and very fine SAND, little very fine to fine weathered gray Shale fragments, soft, wet to saturated.	
						4.0 ▼		No Recovery	
.03	2 1 1 2	2.00	0.7	0	BGD	4 4.4		Olive gray very fine to fine SAND, coarse Sand-sized gray Shale fragments, some fine gray Shale fragments, soft, saturated.	SP
						4.6 4.7		Olive gray SILT + CLAY, little very fine Sand, little very fine to fine gray Shale fragments, saturated.	ML ML -
						5		AA, (4-4.4').	
								No Recovery	
.04	12 24 75 100/.4	2.00	1.9	0	BGD	6.0 6		Olive gray very fine to fine SAND, some very fine to medium weathered gray Shale fragments, trace Silt, soft, saturated.	SP
						6.9 7		Highly weathered SHALE, saturated (6.9-7'), moist (7-7.2'), dry (7.2-7.9').	-
						7.9 8		No Recovery	-

BORING TERMINATED AT 8.2'

NOTES: Bottom of overburden at 6.9'. No samples were collected for chemical analysis.

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LOG OF BORING MW6

Sheet 1 of 1

Sheet 1 of 1

LOG OF BORING NO. MW63-3

PROJECT:	SEVEN LOW PRIORITY AOCs	DEPTH TO WATER (ft):	4.0
PROJECT LOCATION:	SENECA ARMY DEPOT, ROMULUS NY	BORING LOCATION (N/E):	1013181.9 741130.1
ASSOCIATED UNIT/AREA:	SEAD-63	REFERENCE COORDINATE SYSTEM:	New York State Plane
PROJECT NO:	720518-01000	GROUND SURFACE ELEVATION (ft):	631.8
DATE STARTED:	06/14/94	DATUM:	NAD 1983
DATE COMPLETED:	06/14/94	INSPECTOR:	KK
DRILLING CONTRACTOR:	EMPIRE SOILS INVESTIGATIONS	CHECKED BY:	FO
DRILLING METHOD:	HOLLOW STEM AUGER		
SAMPLING METHOD:	2" SPLIT SPOONS		

This log is part of the report prepared by Engineering-Science, Inc. for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations.

Sample Number	Blow Counts (# Blows per 6")	Sample Advance (ft)	Sample Recovery (ft)	VOC Screen-PID (ppm)	Rad Screen (cps)	Depth (ft)	Macro Lithology	DESCRIPTION	USCS
.01	2 3 3 4	2.00	2.0	0	BGD	0.3		Olive gray SILT + fine SAND, some coarse Sand, little organics, loose, moist.	ML
						0.5		Gray coarse sand-sized SHALE fragments, little fine Sand, loose, wet.	GM
						1.2		Brown SILT, trace weathered fine Shale, trace iron-stained Clay, medium stiff to stiff, moist.	ML
						2.0		Brown SILT and tan very fine SAND, trace iron stained Clay, some gray, iron-stained Clay, trace very fine Sand, trace fine weathered shale, medium stiff, moist to wet.	ML
.02	4 5 5 5	2.00	1.8	0	BGD	2.7		Gray-brown, highly iron-stained CLAY, little fine to medium gray Shale fragments, trace weathered fine Shale, medium stiff, moist to wet, trace wetness on Shale fragments.	CL
						3.0		Light brown to brown very fine Sand, trace very fine gray Shale fragments, trace Silt, loose, wet to saturated.	SP
						3.8		Olive gray very fine to fine SAND, little very fine Shale fragments, trace Silt, trace fine to medium Shale fragments, loose, wet to saturated.	SM
						4.0	▼	No Recovery	-
.03	4 4 3 4	2.00	1.3	0	9-21	4.4		AA (2.7'-3.0'), soft, saturated.	SP
						5.3		AA, little medium Shale fragments, very loose, saturated.	SP
						6.0		No Recovery	-
.04	24 78 100/.4	1.40	1.4	0	BGD	6.7		Olive gray very fine to fine SAND, some very fine to fine gray Shale fragments, trace Silt, soft, saturated.	SM
						6.8		Gray highly weathered SHALE, moist to wet.	
						7.4		Gray highly weathered SHALE, dry.	-
								No Recovery	-

BORING TERMINATED AT 8.3'

NOTES: Bottom of overburden at 6.7'. No samples were collected for chemical analysis.

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LOG OF BORING MW63-3

Sheet 1 of 1

SEAD-63 WELL DEVELOPMENT REPORTS

WELL DEVELOPMENT REPORT

ENGINEERING-SCIENCE, INC. CLIENT: USACOE WELL #: MW 63-3

PROJECT: 15 SWMU ESI (SEAD- 63

LOCATION: SENECA ARMY DEPOT, ROMULUS, NY

DATE: 6/26/94

PROJECT NO.: 720518

DRILLING METHOD (s): HSA

PUMP METHOD (s): Peristaltic

SURGE METHOD (s): Teflon Bailer

INSTALLATION DATE: 6/14/94

INSPECTOR: KKS

CONTRACTOR:

CREW:

START DEVELOPMENT DATE: 6/26

END DEVELOPMENT DATE: 427

Stickup - 1.4'

WATER DEPTH (TOC): 4.15 ft

WELL DIA. (ID CASING): 2.0" ft

BORING DIAMETER: 8.5" ft

INSTALLED POW DEPTH(TOC): 8.1 ft

MEASURED POW DEPTH(TOC): 4.5 ft

SILT THICKNESS: ft

POW AFTER DEVELOPMENT: ft

TSP

2.5

DIAMETER FACTORS (GAL/FT):

DIAMETER (IN):	[✓ 2]	3	4	5	6	7	8	[✓ 8.5]	9	10	11	12
GALLONS/FT:	[✓ 0.163]	0.367	0.654	1.02	1.47	2.00	2.61	[✓ 2.95]	3.30	4.08	4.93	5.87

5.35 x .163 =

STANDING VOLUME INSIDE WELL = WATER COLUMN X WELL DIAMETER FACTOR = 0.9 GAL. = A

STANDING WATER IN ANNULAR SPACE = 5.35 x (2.95 - .163) x .3

WATER COL. BELOW SEAL(ft) X (BORING DIAM. FACTOR – WELL DIAM. FACTOR) X 0.3 = 4.47 GAL. = B

SINGLE STANDING WATER VOLUME = A + B = ... 5.4 GAL. = C

MINIMUM VOLUME TO BE REMOVED = 5 X C .... 27 GALS.

Rate	DATE	ACTIVITY	STARTING H2O DEPTH	START TIME	END TIME	ELAPSED TIME	GALLONS REMOVED	pH	CONDUCTIVITY	TEMP	COLOR	Turbidity (NTU)	Ending Water Depth
	6/26	Surge	4.15	1330	1350	20	5.0			[illegible]		dark Brown	7.35
	6/26	Pump 1st Vol	4.58	1445	1505	20	5.0	6.92	2100	16.2	dark Brown	1000+	9.00
	6/26	Pump 2nd Vol	9.00	1505	1525	20	4.5	6.84	2050	15.9	clear	17	9.10
500ml	6/26	Pump 3rd Vol	9.10	1525	1600	35	4.0	6.87	2000	16.3	clear	67	7.0
	6/26	Surge	6.40	1610	1625	15	2.0				dark brown		5.90
1500/650ml	6/26	Pump 4th Vol	5.90	1625	1640	15	4.5	6.95	2000	16.5	clear	24	9.10
480ml	6/26	Pump 5th Vol	9.18	1640	1710	30	4.5	6.83	2100	16.4	clear	27	7.60
500ml	6/27	surge/pump	3.42	0910 0945	0940 1005	20 20	surge 2.5 4.0	6.82	2000	16.2	clear	7	
500ml	6/27	surge/pump		1030 1040	1040 1110	10 30	3.0 5	6.89	2000	16.1	clear	20	7.55
							Complete						
	TOTALS/FINAL						so ~~44.5~~ 49						

RECOVERY

GOOD [✓ FAIR] [✓ POOR]

INVESTIGATION DERIVED WASTE (IDW)

DATE	6/26	6/27			
VOLUME	29.5	19.5			
DRUM #	#63-3	#63-3			

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS WELL #: MW63-3

Note = Maintains 9.0' @ 680 ml/min

H:\ENG\SENECA\15SWMU\FIELDFMS\WELLDEV.WK3

No pressure cap

WELL DEVELOPMENT REPORT

ENGINEERING–SCIENCE, INC.	**CLIENT:** ACOE	**WELL #:** MW63-2

PROJECT: SEAD - 15 SWMU
LOCATION: SEAD-63
DATE: 6/25/94
PROJECT NO.: 720518 ~~730~~

DRILLING METHOD (s): HSA
PUMP METHOD (s): Peristaltic
SURGE METHOD (s): Teflon Bailer
INSTALLATION DATE: 6/14/94

INSPECTOR: KKS
CONTRACTOR:
CREW:
START DEVELOPMENT DATE: 6/25
END DEVELOPMENT DATE: 2/26
Stickup = 1.46'

WATER DEPTH (TOC): 2.98 ft
WELL DIA. (ID CASING): 2.0" ft
BORING DIAMETER: 8.5" ft

INSTALLED POW DEPTH(TOC): 8.1 ft
MEASURED POW DEPTH(TOC): 9.56 ft
SILT THICKNESS: ft
POW AFTER DEVELOPMENT: ft

DIAMETER FACTORS (GAL/FT):

.38
25

DIAMETER (IN):	[✓ 2]	3	4	5	6	7	8	8.5	9	10	11	12
GALLONS/FT:	[✓ 0.163]	0.367	0.654	1.02	1.47	2.00	2.61	2.95	3.30	4.08	4.93	5.87

6.58 × .163 =

STANDING VOLUME INSIDE WELL = WATER COLUMN X WELL DIAMETER FACTOR = 1.07 GAL. = A

STANDING WATER IN ANNULAR SPACE =
WATER COL. BELOW SEAL(ft) X (BORING DIAM. FACTOR – WELL DIAM. FACTOR) X 0.3 = 4.7 GAL. = B
(4.1 - 2.5) × (2.95 - .163) × .3   5.6 × 2.787 × .3

SINGLE STANDING WATER VOLUME = A + B = ... 5.8 GAL. = C

MINIMUM VOLUME TO BE REMOVED = 5 X C .... 29 GALS.

	ACTIVITY	Depth Start	START TIME	END TIME	ELAPSED TIME	GALLONS REMOVED	pH	CONDUCTIVITY	TEMP	COLOR	OTHER	Depth End	
6/25	Surge	2.98	1450	1525	25	5				Dark Brown			
	Pump 1st Vol.	3.22	1530	1550	20	5.8	6.97	660	15.7	Brown	1000+	6.80	
	Pump 2nd Vol	6.80	1550	1610	20	5.8	6.89	625	15.2	Brown	100+	7.80	9
	Pump 3rd Vol	7.80	1610	1630	20	5.8	6.93	630	15.3	Brown	100+	8.00	9
6/26	Pump 4th Vol	3.24	1244	1300	14	5.8	6.95	670	15.5	Light Brown	100+	7.7	/
	Pump 5th Vol	7.7	1300	1320	20	5.8	6.93	630	15.6	Lighter Brown	100+	7.82'	9
	Pump 6th Vol	7.82	1320	1345	25	5.8	6.89	600	15.4	Dark Brown	1000+	8.30	9
	Pump 7th Vol	8.2	1345	1410	25	5.8	6.98	600	15.3	milky clear	67	8.2	8
	Pump 8th Vol	8.2	1410	1430	20	4.0	7.02	600	15.4	clear	10	7.6	8
							Complete						
	TOTALS/FINAL					46							

COMMENTS: Maintains 7' water Level @ 920 ml/min

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS **WELL #:** MW63-2

Waste Water: 6-25-94 • 22.4 gallons • #63-~~1~~2-W
6-26-94 • 27.2 gallons • #63-2-W

WELL DEVELOPMENT REPORT

ENGINEERING-SCIENCE, INC. CLIENT: ACOE WELL #: MW63-1

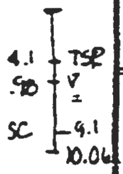
PROJECT: IS SEAD SWMU
LOCATION: SEAD-63
DATE: 6/26/94
PROJECT NO.: 720518

DRILLING METHOD (s): HSA
PUMP METHOD (s): peristaltic
SURGE METHOD (s): teflon bailer
INSTALLATION DATE: 6/14/94

INSPECTOR: ES
CONTRACTOR:
CREW:
START DEVELOPMENT DATE: 6/26/94
END DEVELOPMENT DATE: 6/27/94
Stickup = 1.6'

WATER DEPTH (TOC): 5.98 ft
WELL DIA. (ID CASING): 2" ~~ft~~
BORING DIAMETER: 8.5" ~~ft~~

INSTALLED POW DEPTH ~~(TOC)~~ GS: 8.5 ft
MEASURED POW DEPTH (TOC): 10.06 ft
SILT THICKNESS: ft
POW AFTER DEVELOPMENT: ft



DIAMETER FACTORS (GAL/FT):

DIAMETER (IN):	[✓ 2]	3	4	5	6	7	8	[✓ 8.5]	9	10	11	12
GALLONS/FT:	[✓ 0.163]	0.367	0.654	1.02	1.47	2.00	2.61	[✓ 2.95]	3.30	4.08	4.93	5.87

STANDING VOLUME INSIDE WELL = WATER COLUMN X WELL DIAMETER FACTOR = .7 GAL. = A
(10.06 - 5.98) = 4.08 4.08 × .163

STANDING WATER IN ANNULAR SPACE =
WATER COL. BELOW SEAL(ft) X (BORING DIAM. FACTOR - WELL DIAM. FACTOR) X 0.3 = 3.4 GAL. = B
4.08 × (2.95 - .163) .3 =

SINGLE STANDING WATER VOLUME = A + B = ... 4.1 GAL. = C

MINIMUM VOLUME TO BE REMOVED = 5XC .... 20.5 GALS.

date	ACTIVITY	Start H2O	START TIME	END TIME	ELAPSED TIME	GALLONS REMOVED	pH	CONDUCTIVITY	TEMP	COLOR	Turbidity NTU ~~OTHER~~	Ending H2O Depth
6/26	Surging	5.98	4:15	4:35	20 min.	3+1				Dark Brown		8.10
6/27	surge	6.00	0830	0900	30	3.5				"		10.00
6/27	3 surges	6.48	0930	1100	3x 10min	4.25				"		10.00
6/27	pump	6.55	1140	1240	60	4.1	7.28	410	13.3	clear	11.0	
6/27	pump	8.40	1255	1355	60	3.0	7.19	390	12.6	clear	16.0	8.40
							Complete					
TOTALS/FINAL						18.85						

.125
;
1.5
.20 ml/min

~~COMMENTS:~~
Recovery
GOOD FAIR [✓ POOR]

SEE MASTER ACRONYM LIST FOR COMPLETE LISTING OF ABBREVIATIONS WELL #:

Waste

Date	6/26	6/27
Volume	4	14.85
Drum #	63-4-W	63-4-W

ver. 05-Nov-93

WELLDEV.WK1

APPENDIX C
GAMMA SCANNING DATA

Gamma Scanning Data
SEAD-63 - 50% Coverage
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity
Romulus, NY

				Local Grid System		NAD-27			Site Scan				
Collection Date	Site	Area	line	easting	northing	easting	northing	Min	Mean	Max	background	Units	% +/- BKG
9/30/1997	SEAD-63	G	G-0	120	1877	741250.10	1013408.00	5	8.5	9.5	9.4	kcpm	-9.57%
9/30/1997	SEAD-63	G	G-0	220	1877	741350.00	1013412.00	6.5	8.9	10	9.4	kcpm	-5.32%
9/30/1997	SEAD-63	G	G-0	270	1877	741399.90	1013414.00	6	8.7	10.1	9.4	kcpm	-7.45%
9/30/1997	SEAD-63	G	G-2	120	1871	741250.30	1013402.00	6	8.5	12	9.4	kcpm	-9.57%
9/30/1997	SEAD-63	G	G-2	220	1871	741350.30	1013406.00	6.2	8.7	12	9.4	kcpm	-7.45%
9/30/1997	SEAD-63	G	G-2	270	1871	741400.20	1013408.00	6	9.2	11	9.4	kcpm	-2.13%
9/30/1997	SEAD-63	G	G-4	120	1865	741250.60	1013396.00	7.5	9.5	12	10.2	kcpm	-6.86%
9/30/1997	SEAD-63	G	G-4	220	1865	741350.50	1013400.00	9	10.5	13	10.2	kcpm	2.94%
9/30/1997	SEAD-63	G	G-4	270	1865	741400.40	1013403.00	9.5	10.6	12.5	10.2	kcpm	3.92%
9/30/1997	SEAD-63	G	G-6	120	1859	741250.90	1013390.00	8	9.4	11.5	10.2	kcpm	-7.84%
9/30/1997	SEAD-63	G	G-6	220	1859	741350.80	1013394.00	8.7	10	12.5	10.2	kcpm	-1.96%
9/30/1997	SEAD-63	G	G-6	270	1859	741400.80	1013397.00	8.5	10.5	12	10.2	kcpm	2.94%
9/30/1997	SEAD-63	G	G-8	120	1853	741251.10	1013384.00	5	10.5	13	9.4	kcpm	11.70%
9/30/1997	SEAD-63	G	G-8	220	1853	741351.00	1013388.00	8	11	14	9.4	kcpm	17.02%
9/30/1997	SEAD-63	G	G-8	270	1853	741401.00	1013391.00	8.5	10.8	14	9.4	kcpm	14.89%
9/30/1997	SEAD-63	G	G-10	120	1847	741251.40	1013378.00	6	9.8	13	9.4	kcpm	4.26%
9/30/1997	SEAD-63	G	G-10	220	1847	741351.30	1013382.00	9	11.6	14	9.4	kcpm	23.40%
9/30/1997	SEAD-63	G	G-10	270	1847	741401.30	1013385.00	8	11.2	14	9.4	kcpm	19.15%
9/30/1997	SEAD-63	G	G-12	120	1841	741251.60	1013372.00	6.8	9	12	10.2	kcpm	-11.76%
9/30/1997	SEAD-63	G	G-12	220	1841	741351.60	1013376.00	10.5	12	13.5	10.2	kcpm	17.65%
9/30/1997	SEAD-63	G	G-12	270	1841	741401.50	1013379.00	10	10.5	12	10.2	kcpm	2.94%
9/30/1997	SEAD-63	G	G-14	120	1835	741251.90	1013366.00	7	11	12.4	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-14	220	1835	741351.80	1013370.00	11	12	13.6	10.2	kcpm	17.65%
9/30/1997	SEAD-63	G	G-14	270	1835	741401.80	1013373.00	9.5	11	12	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-16	120	1829	741252.20	1013360.00	6	11.5	14	9.4	kcpm	22.34%
9/30/1997	SEAD-63	G	G-16	220	1829	741352.10	1013364.00	10	11.5	14	9.4	kcpm	22.34%
9/30/1997	SEAD-63	G	G-16	270	1829	741402.10	1013367.00	9	11	14	9.4	kcpm	17.02%
9/30/1997	SEAD-63	G	G-18	120	1823	741252.40	1013354.00	6	10.8	14	9.4	kcpm	14.89%
9/30/1997	SEAD-63	G	G-18	220	1823	741352.40	1013358.00	10	14	14	9.4	kcpm	48.94%
9/30/1997	SEAD-63	G	G-18	270	1823	741402.30	1013361.00	9	13	13	9.4	kcpm	38.30%
9/30/1997	SEAD-63	G	G-20	120	1817	741252.70	1013348.00	7	11	12	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-20	220	1817	741352.60	1013352.00	11	12	13.2	10.2	kcpm	17.65%
9/30/1997	SEAD-63	G	G-20	270	1817	741402.60	1013355.00	10	11	12	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-22	120	1811	741252.90	1013342.00	7.5	11.8	12.8	10.2	kcpm	15.69%
9/30/1997	SEAD-63	G	G-22	220	1811	741352.90	1013346.00	10.5	11.6	13.2	10.2	kcpm	13.73%
9/30/1997	SEAD-63	G	G-22	270	1811	741402.80	1013349.00	9.5	10.5	12	10.2	kcpm	2.94%
9/30/1997	SEAD-63	G	G-24	120	1805	741253.30	1013336.00	6	10.8	14	9.4	kcpm	14.89%
9/30/1997	SEAD-63	G	G-24	220	1805	741353.10	1013340.00	9	11	14	9.4	kcpm	17.02%
9/30/1997	SEAD-63	G	G-24	270	1805	741403.10	1013343.00	9	10.5	14	9.4	kcpm	11.70%
9/30/1997	SEAD-63	G	G-26	120	1799	741253.50	1013330.00	6.5	10.2	14.5	9.4	kcpm	8.51%
9/30/1997	SEAD-63	G	G-26	220	1799	741353.40	1013334.00	10	11.5	14	9.4	kcpm	22.34%
9/30/1997	SEAD-63	G	G-26	270	1799	741403.40	1013337.00	8	11.2	14	9.4	kcpm	19.15%
9/30/1997	SEAD-63	G	G-28	120	1793	741253.80	1013324.00	7	11.5	12.5	10.2	kcpm	12.75%
9/30/1997	SEAD-63	G	G-28	220	1793	741353.70	1013328.00	11	12.2	13.5	10.2	kcpm	19.61%
9/30/1997	SEAD-63	G	G-28	270	1793	741403.60	1013331.00	9.5	10	13	10.2	kcpm	-1.96%
9/30/1997	SEAD-63	G	G-30	120	1787	741254.00	1013318.00	8	11.6	13.5	10.2	kcpm	13.73%
9/30/1997	SEAD-63	G	G-30	220	1787	741353.90	1013322.00	11	12.2	13.8	10.2	kcpm	19.61%
9/30/1997	SEAD-63	G	G-30	270	1787	741403.90	1013325.00	9.5	12	13	10.2	kcpm	17.65%
9/30/1997	SEAD-63	G	G-32	120	1781	741254.30	1013312.00	5.5	10.5	14.5	9.4	kcpm	11.70%
9/30/1997	SEAD-63	G	G-32	220	1781	741354.20	1013316.00	8.5	10.8	14.2	9.4	kcpm	14.89%
9/30/1997	SEAD-63	G	G-32	270	1781	741404.10	1013319.00	9.2	10.5	13.3	9.4	kcpm	11.70%
9/30/1997	SEAD-63	G	G-34	120	1775	741254.60	1013306.00	6.8	11.2	14.5	9.4	kcpm	19.15%
9/30/1997	SEAD-63	G	G-34	220	1775	741354.40	1013310.00	7.8	10.2	14.2	9.4	kcpm	8.51%
9/30/1997	SEAD-63	G	G-34	270	1775	741404.40	1013313.00	8.9	11.1	13.5	9.4	kcpm	18.09%
9/30/1997	SEAD-63	G	G-36	120	1769	741254.80	1013300.00	8.5	11	12.5	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-36	220	1769	741354.70	1013304.00	8.5	11.8	12.8	10.2	kcpm	15.69%
9/30/1997	SEAD-63	G	G-36	270	1769	741404.70	1013307.00	9	10.5	11.5	10.2	kcpm	2.94%
9/30/1997	SEAD-63	G	G-38	120	1763	741255.10	1013294.00	8.5	11	7.2	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-38	220	1763	741355.00	1013298.00	9	10.5	13	10.2	kcpm	2.94%
9/30/1997	SEAD-63	G	G-38	270	1763	741404.90	1013301.00	10.5	11.6	13	10.2	kcpm	13.73%
9/30/1997	SEAD-63	G	G-40	120	1757	741255.30	1013288.00	4.8	11.1	14.2	9.4	kcpm	18.09%
9/30/1997	SEAD-63	G	G-40	220	1757	741355.30	1013292.00	8.5	11.2	13.8	9.4	kcpm	19.15%
9/30/1997	SEAD-63	G	G-40	270	1757	741405.20	1013295.00	9.5	11.6	14	9.4	kcpm	23.40%
9/30/1997	SEAD-63	G	G-42	120	1751	741255.60	1013282.00	5.2	10.5	13.8	9.4	kcpm	11.70%
9/30/1997	SEAD-63	G	G-42	220	1751	741355.50	1013286.00	8.8	11.8	14.8	9.4	kcpm	25.53%
9/30/1997	SEAD-63	G	G-42	270	1751	741405.40	1013289.00	8.8	10.8	14.2	9.4	kcpm	14.89%
9/30/1997	SEAD-63	G	G-44	120	1745	741255.90	1013276.00	6.5	10	12.5	10.2	kcpm	-1.96%
9/30/1997	SEAD-63	G	G-44	220	1745	741355.80	1013280.00	10	11.5	13	10.2	kcpm	12.75%
9/30/1997	SEAD-63	G	G-44	270	1745	741405.70	1013283.00	10.5	11	13	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-46	120	1739	741256.10	1013270.00	8	10.5	12	10.2	kcpm	2.94%
9/30/1997	SEAD-63	G	G-46	220	1739	741356.00	1013274.00	10	12	13	10.2	kcpm	17.65%

Gamma Scanning Data
SEAD-63 - 50% Coverage
SEAD-63 Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity
Romulus, NY

9/30/1997	SEAD-63	G	G-46	270	1739	741406.00	1013277.00	10.5	11.5	12.5	10.2	kcpm	12.75%
9/30/1997	SEAD-63	G	G-48	120	1733	741256.40	1013264.00	5.5	10.6	13.2	9.4	kcpm	12.77%
9/30/1997	SEAD-63	G	G-48	220	1733	741356.30	1013268.00	7.8	11.4	14.5	9.4	kcpm	21.28%
9/30/1997	SEAD-63	G	G-48	270	1733	741406.30	1013271.00	7.8	11.7	13.8	9.4	kcpm	24.47%
9/30/1997	SEAD-63	G	G-50	120	1727	741256.60	1013258.00	7.2	10.7	13.5	9.4	kcpm	13.83%
9/30/1997	SEAD-63	G	G-50	220	1727	741356.60	1013262.00	8.5	11.9	14.8	9.4	kcpm	26.60%
9/30/1997	SEAD-63	G	G-50	270	1727	741406.50	1013265.00	8.8	11.6	13.8	9.4	kcpm	23.40%
9/30/1997	SEAD-63	G	G-52	120	1721	741256.90	1013252.00	8	11	12.5	10.2	kcpm	7.84%
9/30/1997	SEAD-63	G	G-52	220	1721	741356.80	1013256.00	10	11.8	13	10.2	kcpm	15.69%
9/30/1997	SEAD-63	G	G-52	270	1721	741406.80	1013259.00	10.5	11.5	13.2	10.2	kcpm	12.75%
9/30/1997	SEAD-63	G	G-54	120	1715	741257.20	1013246.00	8	11.5	13.2	10.2	kcpm	12.75%
9/30/1997	SEAD-63	G	G-54	220	1715	741357.10	1013250.00	10.8	12	13.5	10.2	kcpm	17.65%
9/30/1997	SEAD-63	G	G-54	270	1715	741407.00	1013253.00	10.5	11.2	13	10.2	kcpm	9.80%
10/1/1997	SEAD-63	G	G-56	120	1709	741257.40	1013240.00	8	11	12.6	9.1	kcpm	20.88%
10/1/1997	SEAD-63	G	G-56	220	1709	741357.30	1013244.00	10.5	11.8	14	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-56	270	1709	741407.30	1013247.00	10.5	11.5	12.3	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-58	120	1703	741257.70	1013234.00	8.5	11.2	13	9.1	kcpm	23.08%
10/1/1997	SEAD-63	G	G-58	220	1703	741357.60	1013238.00	11	12	13.5	9.1	kcpm	31.87%
10/1/1997	SEAD-63	G	G-58	270	1703	741407.60	1013241.00	10	11.1	12.3	9.1	kcpm	21.98%
10/1/1997	SEAD-63	G	G-60	120	1697	741257.90	1013228.00	7.2	11.4	14.5	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-60	220	1697	741357.90	1013232.00	8.5	11.8	15.2	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-60	270	1697	741407.80	1013235.00	8.2	10.5	14.2	9.1	kcpm	15.38%
10/1/1997	SEAD-63	G	G-62	120	1691	741258.30	1013222.00	6.7	11.3	13.5	9.1	kcpm	24.18%
10/1/1997	SEAD-63	G	G-62	220	1691	741358.10	1013226.00	8.5	11.5	14.5	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-62	270	1691	741408.10	1013229.00	6.8	9.8	13.2	9.1	kcpm	7.69%
10/1/1997	SEAD-63	G	G-64	120	1685	741258.50	1013216.00	9	11.5	14	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-64	220	1685	741358.40	1013220.00	11	12	13.5	9.1	kcpm	31.87%
10/1/1997	SEAD-63	G	G-64	270	1685	741408.30	1013223.00	9	9.8	12	9.1	kcpm	7.69%
10/1/1997	SEAD-63	G	G-66	120	1679	741258.80	1013210.00	8.5	11	13	9.1	kcpm	20.88%
10/1/1997	SEAD-63	G	G-66	220	1679	741358.60	1013214.00	10.3	11.5	13	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-66	270	1679	741408.60	1013217.00	8	9.7	11	9.1	kcpm	6.59%
10/1/1997	SEAD-63	G	G-68	120	1673	741259.00	1013204.00	5.8	11.5	14.2	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-68	220	1673	741358.90	1013208.00	7.8	11.2	15.2	9.1	kcpm	23.08%
10/1/1997	SEAD-63	G	G-68	270	1673	741408.90	1013211.00	6.8	9.9	12.5	9.1	kcpm	8.79%
10/1/1997	SEAD-63	G	G-70	120	1667	741259.30	1013198.00	8.2	11.1	14.8	9.1	kcpm	21.98%
10/1/1997	SEAD-63	G	G-70	220	1667	741359.20	1013203.00	7.8	11.4	14.5	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-70	270	1667	741409.10	1013205.00	6.5	9.4	12.5	9.1	kcpm	3.30%
10/1/1997	SEAD-63	G	G-72	120	1661	741259.60	1013192.00	6.5	11.5	13	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-72	220	1661	741359.40	1013197.00	9.5	10.8	12.8	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-72	270	1661	741409.40	1013199.00	8	10.4	11	9.1	kcpm	14.29%
10/1/1997	SEAD-63	G	G-74	120	1655	741259.80	1013186.00	7.5	10.8	12.5	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-74	220	1655	741359.70	1013191.00	9.5	11.5	13	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-74	270	1655	741409.60	1013193.00	8	9.8	12	9.1	kcpm	7.69%
10/1/1997	SEAD-63	G	G-76	120	1649	741260.10	1013180.00	4.8	10.9	14.2	9.1	kcpm	19.78%
10/1/1997	SEAD-63	G	G-76	220	1649	741359.90	1013185.00	8.2	11.5	15.2	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-76	270	1649	741409.90	1013187.00	8.5	10.8	13.5	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-78	120	1643	741260.30	1013174.00	5.2	11.1	13.8	9.1	kcpm	21.98%
10/1/1997	SEAD-63	G	G-78	220	1643	741360.30	1013179.00	8.8	11.6	14.5	9.1	kcpm	27.47%
10/1/1997	SEAD-63	G	G-78	270	1643	741410.20	1013181.00	7.2	10.4	14	9.1	kcpm	14.29%
10/1/1997	SEAD-63	G	G-80	120	1637	741260.60	1013168.00	7.5	11.8	13	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-80	220	1637	741360.50	1013173.00	10.5	11.6	13.6	9.1	kcpm	27.47%
10/1/1997	SEAD-63	G	G-80	270	1637	741410.40	1013175.00	9.5	10.2	11.5	9.1	kcpm	12.09%
10/1/1997	SEAD-63	G	G-82	120	1631	741260.90	1013162.00	8	11.5	12.9	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-82	220	1631	741360.80	1013167.00	10	11	13.2	9.1	kcpm	20.88%
10/1/1997	SEAD-63	G	G-82	270	1631	741410.70	1013169.00	9.5	10.7	12	9.1	kcpm	17.58%
10/1/1997	SEAD-63	G	G-84	120	1625	741261.10	1013156.00	5.2	11.2	13.8	9.1	kcpm	23.08%
10/1/1997	SEAD-63	G	G-84	220	1625	741361.00	1013161.00	7.8	11.5	14	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-84	270	1625	741410.90	1013163.00	8.8	10.5	13.8	9.1	kcpm	15.38%
10/1/1997	SEAD-63	G	G-86	120	1619	741261.40	1013150.00	4.5	11.5	14.2	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-86	220	1619	741361.30	1013155.00	8.8	11.7	14.5	9.1	kcpm	28.57%
10/1/1997	SEAD-63	G	G-86	270	1619	741411.30	1013157.00	8.2	10.6	13.2	9.1	kcpm	16.48%
10/1/1997	SEAD-63	G	G-88	120	1613	741261.60	1013144.00	7	11.8	13.2	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-88	220	1613	741361.60	1013149.00	9.5	11.4	12.5	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-88	270	1613	741411.50	1013151.00	9.5	10.5	11.5	9.1	kcpm	15.38%
10/1/1997	SEAD-63	G	G-90	120	1607	741261.90	1013138.00	8	11.4	12.5	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-90	220	1607	741361.80	1013143.00	10.5	12	13	9.1	kcpm	31.87%
10/1/1997	SEAD-63	G	G-90	270	1607	741411.80	1013145.00	9.5	10.3	12	9.1	kcpm	13.19%
10/1/1997	SEAD-63	G	G-92	120	1601	741262.20	1013132.00	4.2	11.7	14.5	9.1	kcpm	28.57%
10/1/1997	SEAD-63	G	G-92	220	1601	741362.10	1013137.00	9.5	11.8	14.5	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-92	270	1601	741412.00	1013139.00	7.8	10.7	13.2	9.1	kcpm	17.58%
10/1/1997	SEAD-63	G	G-94	120	1595	741262.40	1013126.00	5	11.7	14.5	9.1	kcpm	28.57%
10/1/1997	SEAD-63	G	G-94	220	1595	741362.30	1013131.00	9.5	11.9	14.5	9.1	kcpm	30.77%
10/1/1997	SEAD-63	G	G-94	270	1595	741412.30	1013133.00	7.5	10.9	13.2	9.1	kcpm	19.78%

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10/1/1997	SEAD-63	G	G-96	120	1589	741262.70	1013120.00	7.4	11.5	13.2	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-96	220	1589	741362.60	1013125.00	11.2	11.9	13.6	9.1	kcpm	30.77%
10/1/1997	SEAD-63	G	G-96	270	1589	741412.60	1013127.00	9.5	10.5	12.2	9.1	kcpm	15.38%
10/1/1997	SEAD-63	G	G-98	120	1583	741262.90	1013114.00	7.8	11.2	13	9.1	kcpm	23.08%
10/1/1997	SEAD-63	G	G-98	220	1583	741362.90	1013119.00	11	12	13.2	9.1	kcpm	31.87%
10/1/1997	SEAD-63	G	G-98	270	1583	741412.80	1013121.00	9	10.4	12	9.1	kcpm	14.29%
10/1/1997	SEAD-63	G	G-100	120	1577	741263.20	1013108.00	7	11.6	14	9.1	kcpm	27.47%
10/1/1997	SEAD-63	G	G-100	220	1577	741363.10	1013113.00	8.8	11.8	14.5	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-100	270	1577	741413.10	1013115.00	6.8	10.7	13.8	9.1	kcpm	17.58%
10/1/1997	SEAD-63	G	G-102	120	1571	741263.50	1013102.00	4.7	11.4	14.5	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-102	220	1571	741363.40	1013107.00	8.2	11.8	14	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-102	270	1571	741413.30	1013109.00	7.8	10.6	14.2	9.1	kcpm	16.48%
10/1/1997	SEAD-63	G	G-104	120	1565	741263.80	1013096.00	7.5	11.4	12.4	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-104	220	1565	741363.60	1013101.00	11	11.8	13.8	9.1	kcpm	29.67%
10/1/1997	SEAD-63	G	G-104	270	1565	741413.60	1013103.00	9.5	10.5	12	9.1	kcpm	15.38%
10/1/1997	SEAD-63	G	G-106	120	1559	741264.00	1013090.00	8	11.4	12.5	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-106	220	1559	741363.90	1013095.00	11	11.4	13	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-106	270	1559	741413.90	1013097.00	9.3	10.3	12	9.1	kcpm	13.19%
10/1/1997	SEAD-63	G	G-108	120	1553	741264.30	1013084.00	4.8	11.6	13	9.1	kcpm	27.47%
10/1/1997	SEAD-63	G	G-108	220	1553	741364.20	1013089.00	8.8	11.7	14.8	9.1	kcpm	28.57%
10/1/1997	SEAD-63	G	G-108	250	1553	741394.10	1013090.00	7.5	10.8	12.5	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-110	120	1547	741264.50	1013078.00	5	11.4	14.2	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-110	220	1547	741364.40	1013083.00	8	11.5	14	9.1	kcpm	26.37%
10/1/1997	SEAD-63	G	G-110	270	1547	741414.40	1013085.00	7.5	10.6	12.5	9.1	kcpm	16.48%
10/1/1997	SEAD-63	G	G-112	120	1541	741264.80	1013072.00	8	10.8	12	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-112	220	1541	741364.70	1013077.00	10.5	11.4	12	9.1	kcpm	25.27%
10/1/1997	SEAD-63	G	G-112	270	1541	741414.60	1013079.00	9.5	10	11.5	9.1	kcpm	9.89%
10/1/1997	SEAD-63	G	G-114	120	1535	741265.10	1013066.00	7.8	11	11.9	9.1	kcpm	20.88%
10/1/1997	SEAD-63	G	G-114	220	1535	741364.90	1013071.00	10.2	11	12.5	9.1	kcpm	20.88%
10/1/1997	SEAD-63	G	G-114	270	1535	741414.90	1013073.00	9	10.2	10.8	9.1	kcpm	12.09%
10/1/1997	SEAD-63	G	G-116	120	1529	741265.30	1013060.00	4.8	10.4	14	9.1	kcpm	14.29%
10/1/1997	SEAD-63	G	G-116	220	1529	741365.20	1013065.00	9	10.9	14.2	9.1	kcpm	19.78%
10/1/1997	SEAD-63	G	G-116	270	1529	741415.20	1013067.00	7.8	10.9	12.6	9.1	kcpm	19.78%
10/1/1997	SEAD-63	G	G-118	120	1523	741265.60	1013054.00	5	11	13.2	9.1	kcpm	20.88%
10/1/1997	SEAD-63	G	G-118	220	1523	741365.50	1013059.00	7.8	11.1	13.2	9.1	kcpm	21.98%
10/1/1997	SEAD-63	G	G-118	270	1523	741415.40	1013061.00	7.5	10.2	12.5	9.1	kcpm	12.09%
10/1/1997	SEAD-63	G	G-120	120	1517	741265.80	1013048.00	8	10.5	11.8	9.1	kcpm	15.38%
10/1/1997	SEAD-63	G	G-120	220	1517	741365.80	1013053.00	10.2	11.3	12.3	9.1	kcpm	24.18%
10/1/1997	SEAD-63	G	G-120	270	1517	741415.70	1013055.00	8.5	10.4	11	9.1	kcpm	14.29%
10/1/1997	SEAD-63	G	G-122	120	1511	741266.10	1013042.00	7.5	11.2	12.4	9.1	kcpm	23.08%
10/1/1997	SEAD-63	G	G-122	220	1511	741366.00	1013047.00	10.2	10.8	12.5	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-122	270	1511	741415.90	1013049.00	8.8	10	11	9.1	kcpm	9.89%
10/1/1997	SEAD-63	G	G-124	120	1505	741266.40	1013036.00	4.8	10.8	14.2	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-124	220	1505	741366.30	1013041.00	9.2	10.9	13.5	9.1	kcpm	19.78%
10/1/1997	SEAD-63	G	G-124	270	1505	741416.30	1013043.00	7.2	9.9	12.8	9.1	kcpm	8.79%
10/1/1997	SEAD-63	G	G-126	120	1499	741266.60	1013030.00	4	10.7	13.2	9.1	kcpm	17.58%
10/1/1997	SEAD-63	G	G-126	220	1499	741366.50	1013035.00	8	10.8	13	9.1	kcpm	18.68%
10/1/1997	SEAD-63	G	G-126	270	1499	741416.50	1013037.00	7.8	9.6	12	9.1	kcpm	5.49%
10/2/1997	SEAD-63	G	G-128	120	1493	741266.90	1013024.00	7	11.5	12.8	9.3	kcpm	23.66%
10/2/1997	SEAD-63	G	G-128	220	1493	741366.80	1013029.00	9	10.5	11.5	9.3	kcpm	12.90%
10/2/1997	SEAD-63	G	G-128	270	1493	741416.80	1013031.00	8.5	10.2	11.4	9.3	kcpm	9.68%
10/2/1997	SEAD-63	G	G-130	120	1487	741267.10	1013018.00	7.7	11.6	12.8	9.3	kcpm	24.73%
10/2/1997	SEAD-63	G	G-130	220	1487	741367.10	1013023.00	9.8	11.4	12	9.3	kcpm	22.58%
10/2/1997	SEAD-63	G	G-130	270	1487	741417.00	1013025.00	9	10.5	11.3	9.3	kcpm	12.90%
10/2/1997	SEAD-63	G	G-132	120	1481	741267.40	1013012.00	5.5	11.5	14.2	9.2	kcpm	25.00%
10/2/1997	SEAD-63	G	G-132	220	1481	741367.30	1013017.00	8.8	11.1	13.2	9.2	kcpm	20.65%
10/2/1997	SEAD-63	G	G-132	270	1481	741417.30	1013019.00	8.5	10.9	13.5	9.2	kcpm	18.48%
10/2/1997	SEAD-63	G	G-134	120	1475	741267.70	1013006.00	5.8	11.4	13.5	9.2	kcpm	23.91%
10/2/1997	SEAD-63	G	G-134	220	1475	741367.60	1013011.00	9.2	11.2	13.8	9.2	kcpm	21.74%
10/2/1997	SEAD-63	G	G-134	270	1475	741417.60	1013013.00	7.8	10.8	12.8	9.2	kcpm	17.39%
10/2/1997	SEAD-63	G	G-136	120	1469	741267.90	1013000.00	7.5	11.6	13	9.3	kcpm	24.73%
10/2/1997	SEAD-63	G	G-136	220	1469	741367.90	1013005.00	10	11.2	12.9	9.3	kcpm	20.43%
10/2/1997	SEAD-63	G	G-136	270	1469	741417.80	1013007.00	9	10.4	12	9.3	kcpm	11.83%
10/2/1997	SEAD-63	G	G-138	120	1463	741268.20	1012994.00	7	11.6	12.9	9.3	kcpm	24.73%
10/2/1997	SEAD-63	G	G-138	220	1463	741368.10	1012999.00	10.5	11.5	12.8	9.3	kcpm	23.66%
10/2/1997	SEAD-63	G	G-138	270	1463	741418.10	1013001.00	8.7	10.6	11.5	9.3	kcpm	13.98%
10/2/1997	SEAD-63	G	G-140	120	1457	741268.40	1012988.00	4.8	11.9	14.2	9.2	kcpm	29.35%
10/2/1997	SEAD-63	G	G-140	220	1457	741368.40	1012993.00	8.8	11.8	14.8	9.2	kcpm	28.26%
10/2/1997	SEAD-63	G	G-140	270	1457	741418.30	1012995.00	8.5	10.6	12.8	9.2	kcpm	15.22%
10/2/1997	SEAD-63	G	G-142	120	1451	741268.80	1012982.00	4.8	11.6	14	9.2	kcpm	26.09%
10/2/1997	SEAD-63	G	G-142	220	1451	741368.60	1012987.00	8.5	11.7	14.2	9.2	kcpm	27.17%
10/2/1997	SEAD-63	G	G-142	270	1451	741418.60	1012989.00	7.8	10.4	13.8	9.2	kcpm	13.04%
10/2/1997	SEAD-63	G	G-144	120	1445	741269.00	1012976.00	7	11.6	13	9.3	kcpm	24.73%

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10/2/1997	SEAD-63	G	G-144	220	1445	741368.90	1012981.00	10.8	11.6	12.9	9.3	kcpm	24.73%
10/2/1997	SEAD-63	G	G-144	270	1445	741418.90	1012983.00	9.6	10.5	11.8	9.3	kcpm	12.90%
10/2/1997	SEAD-63	G	G-146	120	1439	741269.30	1012970.00	7	11.7	12.4	9.3	kcpm	25.81%
10/2/1997	SEAD-63	G	G-146	220	1439	741369.20	1012975.00	11	11.8	13	9.3	kcpm	26.88%
10/2/1997	SEAD-63	G	G-146	270	1439	741419.10	1012977.00	9.5	10.4	11.5	9.3	kcpm	11.83%
10/2/1997	SEAD-63	G	G-148	120	1433	741269.50	1012964.00	5	11.5	13.8	9.2	kcpm	25.00%
10/2/1997	SEAD-63	G	G-148	220	1433	741369.40	1012969.00	8	11.7	14	9.2	kcpm	27.17%
10/2/1997	SEAD-63	G	G-148	270	1433	741419.40	1012971.00	9.2	10.7	13.5	9.2	kcpm	16.30%
10/2/1997	SEAD-63	G	G-150	120	1427	741269.80	1012958.00	4.8	11.4	13.8	9.2	kcpm	23.91%
10/2/1997	SEAD-63	G	G-150	220	1427	741369.70	1012963.00	9.8	11.8	14.2	9.2	kcpm	28.26%
10/2/1997	SEAD-63	G	G-150	270	1427	741419.60	1012965.00	6.8	10.5	13	9.2	kcpm	14.13%
10/2/1997	SEAD-63	G	G-152	120	1421	741270.10	1012952.00	7.5	10	11.5	9.3	kcpm	7.53%
10/2/1997	SEAD-63	G	G-152	220	1421	741369.90	1012957.00	10.8	11.5	12.2	9.3	kcpm	23.66%
10/2/1997	SEAD-63	G	G-152	270	1421	741419.90	1012959.00	9	10.4	11.8	9.3	kcpm	11.83%
10/2/1997	SEAD-63	G	G-154	120	1415	741270.30	1012946.00	6.5	10.5	12	9.3	kcpm	12.90%
10/2/1997	SEAD-63	G	G-154	220	1415	741370.20	1012951.00	11	11.5	13	9.3	kcpm	23.66%
10/2/1997	SEAD-63	G	G-154	270	1415	741420.20	1012953.00	9	9.8	11	9.3	kcpm	5.38%
10/2/1997	SEAD-63	G	G-156	120	1409	741270.60	1012940.00	5.5	10.1	13.2	9.2	kcpm	9.78%
10/2/1997	SEAD-63	G	G-156	220	1409	741370.50	1012945.00	9.8	11.9	14.5	9.2	kcpm	29.35%
10/2/1997	SEAD-63	G	G-156	270	1409	741420.40	1012947.00	7.9	10.2	13	9.2	kcpm	10.87%
10/2/1997	SEAD-63	G	G-158	120	1403	741270.80	1012934.00	5.2	9.8	13.5	9.2	kcpm	6.52%
10/2/1997	SEAD-63	G	G-158	220	1403	741370.80	1012939.00	9.2	11.7	13.8	9.2	kcpm	27.17%
10/2/1997	SEAD-63	G	G-158	270	1403	741420.70	1012941.00	6	9.8	12.5	9.2	kcpm	6.52%
10/2/1997	SEAD-63	G	G-160	120	1397	741271.10	1012928.00	7.5	9.4	11.2	9.3	kcpm	1.08%
10/2/1997	SEAD-63	G	G-160	220	1397	741371.00	1012933.00	9	11	12.2	9.3	kcpm	18.28%
10/2/1997	SEAD-63	G	G-160	270	1397	741420.90	1012935.00	9	10.7	13	9.3	kcpm	15.05%
10/2/1997	SEAD-63	G	G-162	120	1391	741271.40	1012922.00	6.5	10	11.8	9.3	kcpm	7.53%
10/2/1997	SEAD-63	G	G-162	220	1391	741371.30	1012927.00	11	11.3	12.7	9.3	kcpm	21.51%
10/2/1997	SEAD-63	G	G-162	270	1391	741421.20	1012929.00	8.5	10	11.4	9.3	kcpm	7.53%
10/2/1997	SEAD-63	G	G-164	120	1385	741271.60	1012916.00	5.8	10.4	14.2	9.2	kcpm	13.04%
10/2/1997	SEAD-63	G	G-164	220	1385	741371.50	1012921.00	5.8	11.3	14	9.2	kcpm	22.83%
10/2/1997	SEAD-63	G	G-164	270	1385	741421.50	1012923.00	7.8	9.8	13.2	9.2	kcpm	6.52%
10/2/1997	SEAD-63	G	G-166	120	1379	741271.90	1012910.00	8.5	10.7	13.5	9.2	kcpm	16.30%
10/2/1997	SEAD-63	G	G-166	220	1379	741371.80	1012915.00	9.5	11.5	14.2	9.2	kcpm	25.00%
10/2/1997	SEAD-63	G	G-166	270	1379	741421.80	1012917.00	7.8	10	11.8	9.2	kcpm	8.70%
10/2/1997	SEAD-63	G	G-168	120	1373	741272.10	1012904.00	6.5	10.9	12	9.3	kcpm	17.20%
10/2/1997	SEAD-63	G	G-168	220	1373	741372.10	1012909.00	10	11.5	12.8	9.3	kcpm	23.66%
10/2/1997	SEAD-63	G	G-168	270	1373	741422.00	1012911.00	8.3	9.8	11	9.3	kcpm	5.38%
10/2/1997	SEAD-63	G	G-170	120	1367	741272.40	1012898.00	7	11.5	12.9	9.3	kcpm	23.66%
10/2/1997	SEAD-63	G	G-170	220	1367	741372.30	1012903.00	11.2	11.7	13	9.3	kcpm	25.81%
10/2/1997	SEAD-63	G	G-170	270	1367	741422.30	1012905.00	9.2	9.8	11.3	9.3	kcpm	5.38%
10/2/1997	SEAD-63	G	G-172	120	1361	741272.70	1012892.00	4.2	11.4	14.5	9.2	kcpm	23.91%
10/2/1997	SEAD-63	G	G-172	220	1361	741372.60	1012897.00	9.5	11.8	13.8	9.2	kcpm	28.26%
10/2/1997	SEAD-63	G	G-172	270	1361	741422.50	1012899.00	7.8	10.5	13.8	9.2	kcpm	14.13%
10/2/1997	SEAD-63	G	G-174	120	1355	741272.90	1012886.00	5.7	11	13.8	9.2	kcpm	19.57%
10/2/1997	SEAD-63	G	G-174	220	1355	741372.80	1012891.00	8.8	11.8	14	9.2	kcpm	28.26%
10/2/1997	SEAD-63	G	G-174	270	1355	741422.80	1012893.00	6.8	10.2	13	9.2	kcpm	10.87%
10/2/1997	SEAD-63	G	G-176	120	1349	741273.20	1012880.00	6.5	11.4	12.5	9.3	kcpm	22.58%
10/2/1997	SEAD-63	G	G-176	220	1349	741373.10	1012885.00	11	11.7	13	9.3	kcpm	25.81%
10/2/1997	SEAD-63	G	G-176	270	1349	741423.10	1012887.00	8	9.5	9.8	9.3	kcpm	2.15%
10/2/1997	SEAD-63	G	G-178	120	1343	741273.40	1012874.00	6.5	11.2	12.1	9.3	kcpm	20.43%
10/2/1997	SEAD-63	G	G-178	220	1343	741373.40	1012879.00	10.8	11.7	13	9.3	kcpm	25.81%
10/2/1997	SEAD-63	G	G-178	270	1343	741423.30	1012881.00	8	9.6	10	9.3	kcpm	3.23%
10/2/1997	SEAD-63	G	G-180	120	1337	741273.80	1012868.00	3.8	10.4	13.5	9.2	kcpm	13.04%
10/2/1997	SEAD-63	G	G-180	220	1337	741373.60	1012873.00	8.2	11.1	13.5	9.2	kcpm	20.65%
10/2/1997	SEAD-63	G	G-180	270	1337	741423.60	1012875.00	7.8	10	12	9.2	kcpm	8.70%
10/2/1997	SEAD-63	G	G-182	120	1331	741274.00	1012862.00	4.5	10.6	13.5	9.2	kcpm	15.22%
10/2/1997	SEAD-63	G	G-182	220	1331	741373.90	1012867.00	7.8	10.2	12.5	9.2	kcpm	10.87%
10/2/1997	SEAD-63	G	G-182	270	1331	741423.80	1012869.00	8.2	9.8	12.5	9.2	kcpm	6.52%
10/2/1997	SEAD-63	G	G-184	120	1325	741274.30	1012856.00	6	8.8	9.2	9.3	kcpm	-5.38%
10/2/1997	SEAD-63	G	G-184	220	1325	741374.10	1012861.00	8.5	10.1	10.9	9.3	kcpm	8.60%
10/2/1997	SEAD-63	G	G-184	270	1325	741424.10	1012863.00	8.5	9.6	10.5	9.3	kcpm	3.23%
10/2/1997	SEAD-63	G	G-186	120	1319	741274.50	1012850.00	6.5	7	8	9.3	kcpm	-24.73%
10/2/1997	SEAD-63	G	G-186	220	1319	741374.40	1012855.00	6.8	8.2	8.7	9.3	kcpm	-11.83%
10/2/1997	SEAD-63	G	G-186	270	1319	741424.40	1012857.00	7.5	8.1	8.8	9.3	kcpm	-12.90%
10/2/1997	SEAD-63	G	G-188	120	1313	741274.80	1012844.00	5	6.5	7.2	9.2	kcpm	-29.35%
10/2/1997	SEAD-63	G	G-188	220	1313	741374.70	1012849.00	6.5	6.5	7.6	9.2	kcpm	-29.35%
10/2/1997	SEAD-63	G	G-188	270	1313	741424.60	1012851.00	6.2	7	7.8	9.2	kcpm	-23.91%

APPENDIX D
BACKGROUND AND PHASE I RI DATA

RADIONUCLIDE BACKGROUND DATA

TABLE D-1: SOIL
TABLE D-2: SURFACE WATER
TABLE D-3: SEDIMENT
TABLE D-4: GROUNDWATER

CHEMICAL INORGANICS BACKGROUND DATA

TABLE D-5: SOIL
TABLE D-6: GROUNDWATER

SURFACE WATER AND SEDIMENT DATA COLLECTED DURING PHASE I RI

TABLE D-7: SEDIMENT DATA
TABLE D-8: SURFACE WATER DATA

RADIONUCLIDE BACKGROUND DATA

TABLE D-1: SOIL
TABLE D-2: SURFACE WATER
TABLE D-3: SEDIMENT
TABLE D-4: GROUNDWATER

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BACKGROUND RADIONULCIDE DATA SET

	LOC_ID	MW12-1			MW12-1			MW12-1			MW12-2		
	SAMP_ID	12506			12507			12508			12512		
	DEPTH_TOP	0.2			0			4			0		
	DEPTH_BOT	2			0.2			6			0.2		
	MATRIX	SOIL			SOIL			SOIL			SOIL		
Parameter	**Units**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**
Bismuth-214	pCi/g	1.2	J	0.3	1.3	UJ		1.4	J	0.3	1.1	J	0.4
Cesium-137	pCi/g	0.2	U		0.6		0.2	0.2	U		0.7		0.2
Cobalt-57	pCi/g	0.1	U		0.1	U		0.1	U		0.1	U	
Cobalt-60	pCi/g	0.2	U		0.2	U		0.3	U		0.4	U	
Lead-210	pCi/g	21.6	U		23.2	U		1.2	U		25.9	U	
Lead-211	pCi/g	4.5	U		13.8	U		2	U		11.6	U	
Lead-214	pCi/g	1.2		0.2	1.3		0.3	1.2		0.3	1.3		0.2
Moisture (@ 104 deg C)	% by Wt	16.9			25.2			9.9			29.3		
Plutonium-239/240	pCi/g	0.2		0.2	0.2	J	0.3	0.1		0.1	0.3	U	0.1
Promethium 147	pCi/g	13.3	U	5.1	14.4	U	5.1	9.6	U	5	10.3	U	5
Radium-223	pCi/g	0.4	U		0.3	U		0.4	U		0.4	U	
Radium-226	pCi/g	1.2	J	0.3	1.3	UJ		1.4	J	0.3	1.1	J	0.4
Radium-228	pCi/g	2	J	0.5	1.8	J	0.4	2.1	J	0.4	1.7	J	0.4
Thorium-227	pCi/g	0.3	UJ	0.1	0.6	U	0.1	0.4	UJ	0.1	0.1	J	0.2
Thorium-230	pCi/g	1.7	UJ	0.8	1.8	U	0.9	1.8	UJ	0.9	2.1	UJ	1
Thorium-232	pCi/g	0.9	J	0.5	1.3		0.8	1.1	J	0.6	1.2	J	0.7
Tritium	pCi/g	0.1	UJ	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	U	0.1
Uranium-233/234	pCi/g	1.1	UJ	0.4	0.6	UJ	0.3	1.1	UJ	0.4	1.6	UJ	0.4
Uranium-235	pCi/g	0.1	U	0.1	0.1	U	0.1	0.1	U	0.1	0.1	U	0.1
Uranium-238	pCi/g	0.6	J	0.3	0.7		0.3	1		0.3	0.8		0.3

TABLE D-1
SENECA ARMY DEPOT
SOIL DATA
BACKGROUND RADIONULCIDE DATA SET

	LOC_ID	MW12-2			MW12-3			MW12-3			MW12-3			MW12-4		
	SAMP_ID	12513			12509			12510			12511			12501		
	DEPTH_TOP	2			0			0.2			6			4		
	DEPTH_BOT	4			0.2			2			8			5.4		
	MATRIX	SOIL			SOIL			SOIL			SOIL			SOIL		
Parameter	Units	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error
Bismuth-214	pCi/g	1.6	UJ		1.4	J	0.4	1.5	J	0.4	1.5	J	0.4	1	J	0.3
Cesium-137	pCi/g	0.2	U		0.9	U		0.1	U		0.1	U		0.1	U	
Cobalt-57	pCi/g	0.1	U		0.1	U		0.1	U		0.1	U		0.1	U	
Cobalt-60	pCi/g	0.4	U		0.1	U		0.3	U		0.5	U		0.1	U	
Lead-210	pCi/g	3.1	U		2.3	U		14.7	U		4.1	U		17	U	
Lead-211	pCi/g	1.4	U		6.3	U		4.1	U		5.3	U		0.8	U	
Lead-214	pCi/g	1.6		0.4	1.3		0.3	1.5		0.3	1.1		0.3	1		0.2
Moisture (@ 104 deg C)	% by Wt	13.1			22.2			16.9			9.4			10.9		
Plutonium-239/240	pCi/g	0.3	UJ	0.1	0.2	J	0.2	0.3	UJ	0.1	0.2		0.2	0.1		0.1
Promethium 147	pCi/g	5.1	U	5	8.3	U	5	5.6	U	5	6.5	U	5	3.2		3.7
Radium-223	pCi/g	0.4	U		0.5	U		0.4	U		0.4	U		0.3	U	
Radium-226	pCi/g	1.6	UJ		1.4	J	0.4	1.5	J	0.4	1.5	J	0.4	1	J	0.3
Radium-228	pCi/g	3.5	J	0.6	1.4	J	0.5	2.1	J	0.5	1.7	J	0.4	1.5	J	0.4
Thorium-227	pCi/g	0.1		0.2	0.1		0.1	0.2	U	0.1	0.2		0.2	0.5	UJ	0.2
Thorium-230	pCi/g	1	U	0.6	1.5	U	0.7	2.9	U	1.1	1.1	U	0.6	1.8	UJ	0.9
Thorium-232	pCi/g	0.9		0.5	1.1		0.6	1.2		0.6	0.8		0.5	2	J	0.9
Tritium	pCi/g	0.1	U	0.1	0.4	UJ	0.1	0.1	U	0.1	0.1	U	0.1	0.1	UJ	0.1
Uranium-233/234	pCi/g	0.7	UJ	0.3	0.7	UJ	0.3	0.5	UJ	0.2	1	UJ	0.3	0.9	UJ	0.3
Uranium-235	pCi/g	0.1	U	0.1	0.1	U	0.1	0.1	U	0.1	0.1	U	0.1	0.1	U	0.1
Uranium-238	pCi/g	0.7		0.2	0.6	U	0.2	0.6	U	0.2	0.7		0.3	0.6		0.2

SENECA ARMY DEPOT
SOIL DATA
BACKGROUND RADIONULCIDE DATA SET

	LOC_ID	MW12-4			MW12-4			MW12-5			MW12-5			MW12-5		
	SAMP_ID	12502			12505			12500			12503			12504		
	DEPTH_TOP	6			0			2			8			0		
	DEPTH_BOT	8			0 2			3 5			9 7			0 2		
	MATRIX	SOIL			SOIL			SOIL			SOIL			SOIL		
Parameter	**Units**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**
Bismuth-214	pCi/g	1	J	0 3	1 9	J	0 4	1 2	J	0 3	1 1	J	0.4	1 5	J	0 2
Cesium-137	pCi/g	0 3	U		0 7		0 2	0 1	U		0 1	U		0.9	U	
Cobalt-57	pCi/g	0 1	U		0 2	U		0 1		0.1	0 1	U		0.2	U	
Cobalt-60	pCi/g	0 2	U		0 3	U		0 2	U		0 1	U		0.1	U	
Lead-210	pCi/g	1 2	U		1 3	U		3 7	U		15 6	U		3.9	U	
Lead-211	pCi/g	2 2	U		9 7	U		1 5	U		1 3	U		10 7	U	
Lead-214	pCi/g	1 3		0 3	1 1		0 3	1 5		0 4	1		0.2	1 4		0 4
Moisture (@ 104 deg C)	% by Wt	9 2			17 8			9 1			8 9			18 7		
Plutonium-239/240	pCi/g	0 1	J	0 1	0 2		0 1	0 2	U	0 1	0 3	U	0 1	0 3	UJ	0 1
Promethium 147	pCi/g	2 1		3 7	7 9	U	5	10		3.9	2 1		3 7	8 9	U	5
Radium-223	pCi/g	0 3	U		0 6	U		0 4	U		0 3	U		0 6	U	
Radium-226	pCi/g	1	J	0 3	1 9	J	0 4	1 2	J	0 3	1 1	J	0 4	1 5	J	0 2
Radium-228	pCi/g	1	J	0 4	1 5	J	0 4	1 8	J	0 4	1 1	J	0 2	1 6	J	0 4
Thorium-227	pCi/g	0 1		0 3	0 3	J	0 3	0 4	J	0 4	0 3	J	0 5	0 3	U	0 1
Thorium-230	pCi/g	0 9	U	0 5	2 7	J	1 3	1 9	UJ	0 9	1 7	UJ	1 1	1 5	U	0 7
Thorium-232	pCi/g	0 9		0 5	0 9	UJ	0 6	1 4	J	0 7	0 8	J	0 7	1 2		0 6
Tritium	pCi/g	0 1	UJ	0 1	0 5	J	0 1	0 1	UJ	0 1	0 1	UJ	0 1	0 5	J	0 1
Uranium-233/234	pCi/g	1	UJ	0 4	0 9	UJ	0 3	0 7	UJ	0 3	1	UJ	0 3	0 6	UJ	0 2
Uranium-235	pCi/g	0 1	U	0 1	0 1	U	0 1	0 2	U	0 1	0 1	U	0 1	0.1	U	0 1
Uranium-238	pCi/g	0 5	U	0 2	0 8		0.3	0.7		0 3	0 9		0.3	0 9		0 3

TABLE D-1
SENECA ARMY DEPOT
SOIL DATA
BACKGROUND RADIONULCIDE DATA SET

	LOC_ID	MW12-6			MW12-6			MW12-6			SS12-1			SS12-10		
	SAMP_ID	123190			123191			123192			12536			12545		
	DEPTH_TOP	0			4			6			0			0		
	DEPTH_BOT	0 2			6			8			0.2			0.2		
	MATRIX	SOIL			SOIL			SOIL			SOIL			SOIL		
Parameter	Units	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error
Bismuth-214	pCi/g	1 7		0 4	1 2		0 4	1 4		0 4	1.6	J	0.3	1 4	UJ	
Cesium-137	pCi/g	0.6		0 2	0 3		0 2	0 4		0 2	0.4	U		0 7		0.2
Cobalt-57	pCi/g	0 1	U		0 1		0 1	0 1		0.1	0.1	U		0 1	U	
Cobalt-60	pCi/g	0 1		0 1	0 2		0 1	0 1		0.1	0 1	U		0 2	U	
Lead-210	pCi/g	4 3	J	2 4	1 5	UJ		2 6	J	1.7	33 6	U		23.6	U	
Lead-211	pCi/g	1.8	U		10		8 6	1 5	U		9 7		3 3	1 3	U	
Lead-214	pCi/g	1.3		0.3	1 5		0 4	1 2		0 3	1 5		0.3	2		0 3
Moisture (@ 104 deg C)	% by Wt	24 7			10 5			10 4			25 8			38 2		
Plutonium-239/240	pCi/g	0.2	U	0 1	0 2	U	0 1	0 1	U	0.1	0 1	UJ	0 3	0 2	U	0 1
Promethium 147	pCi/g										13 4		5.2	7 8	U	5.1
Radium-223	pCi/g	0 4	U		0 4	U		0 3	U		1 4	U		0.4	U	
Radium-226	pCi/g	1 7		0 4	1 2		0 4	1 4		0 4	1.6	J	0 3	1.4	UJ	
Radium-228	pCi/g	1 2	J	0 4	1 5	J	0 4	1 5	J	0 4	1 5	J	0 5	1 6	J	0 6
Thorium-227	pCi/g										0 1	UJ	0.3	0.3	UJ	0 4
Thorium-230	pCi/g	1	J	0 5	0 5	J	0 3	0 2	J	0 4	0 5	UJ	1	1.7	J	0 8
Thorium-232	pCi/g	1.1		0 5	0 5		0 3	0 7	J	0.5	0.9	J	0.8	1 5		0.8
Tritium	pCi/g	14.2	J	0 2	0 1	UJ	0 1	0 1	UJ	0.1	0.1	UJ	0.1	0 1	UJ	0.1
Uranium-233/234	pCi/g	1		0 3	0 6		0 2	0 5		0 2	0.5	U	0 2	1.1		0.4
Uranium-235	pCi/g	0 1		0 1	0 1		0 1	0 1		0 1	0 1		0.1	0.2		0.1
Uranium-238	pCi/g	1.2		0.4	0.8		0.3	0.4		0.2	0.6	U	0.2	1		0.4

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SENECA , JEPOT
SOIL DATA
BACKGROUND RADIONULCIDE DATA SET

	LOC_ID	SS12-11			SS12-12			SS12-13			SS12-13			SS12-14		
	SAMP_ID	12542			12544			12212			12543			12541		
	DEPTH_TOP	0			0			0			0			0		
	DEPTH_BOT	0 2			0 2			0 2			0 2			0 2		
	MATRIX	SOIL			SOIL			SOIL			SOIL			SOIL		
Parameter	**Units**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**
Bismuth-214	pCi/g	1 2	UJ		1 4	J	0 4	1 3	J	0 3	1 6	UJ		1 5	UJ	
Cesium-137	pCi/g	0 6		0 1	0 9	U		0 5	J	0.1	0 6	UJ		0.3	U	
Cobalt-57	pCi/g	0 1	U		0 1	U		0 1	U		0 1	U		0 1	U	
Cobalt-60	pCi/g	0 5	U		0 3	U		0 3	U		0.4	U		0 3	U	
Lead-210	pCi/g	42 2	U		4 8	U		21 7	U		4.3	U		3 7		1 3
Lead-211	pCi/g	3 9		1 8	0 9	U		1 2	U		10	U		3 5	U	
Lead-214	pCi/g	1 2		0 2	2 2		0 5	1 9		0 5	2		0 4	1 5		0 5
Moisture (@ 104 deg C)	% by Wt	30 3			35 8			29.8			27.2			28 2		
Plutonium-239/240	pCi/g	0 3	UJ	0 2	0.4	UJ	0 2	0 3	UJ	0 1	0 2	U	0 1	0 3	UJ	0.1
Promethium 147	pCi/g	15 2	U	5 2	17 8		5 3	10 5	U	5 2	7 7	U	5.1	9 5	U	5 1
Radium-223	pCi/g	0 3	U		0 4	U		0 4	U		0.5	U		0.5	U	
Radium-226	pCi/g	1 2	UJ		1 4	J	0 4	1 3	J	0 3	1 6	UJ		1 5	UJ	
Radium-228	pCi/g	1 7	J	0 5	1 9	J	0.7	1 4	J	0 4	1 7	J	0.6	2 3	J	0 5
Thorium-227	pCi/g	0 5	U	0 5	0 5	U	0 5	0 3	U	0 4	0 1	U	0 2	0 6	UJ	0 1
Thorium-230	pCi/g	1 1	UJ	0 7	1 3	UJ	0 9	1	UJ	0.9	1 4	UJ	0 9	0.8	UJ	0 9
Thorium-232	pCi/g	0 8		0 6	0 9		0 7	0 9	J	0 7	1 7	J	0 8	0 5	J	0 6
Tritium	pCi/g	0 1	UJ	0 1	0 1	UJ	0 1	60 4	J	0 8	0 1	UJ	0 1	0 1	UJ	0.1
Uranium-233/234	pCi/g	0 8	UJ	0.3	1 1		0 3	0 7		0 3	0 9		0.3	0 7	J	0 4
Uranium-235	pCi/g	0 4	UJ	0 2	0 2		0 1	0 1		0 1	0.1		0 1	0 4	J	0 3
Uranium-238	pCi/g	0.8	J	0 3	0.7	U	0 3	0 7		0 3	0.7		0.3	1.2	J	0.5

TABLE D-1
SENECA ARMY DEPOT
SOIL DATA
BACKGROUND RADIONULCIDE DATA SET

	LOC_ID	SS12-2			SS12-3			SS12-4			SS12-5			SS12-6		
	SAMP_ID	12535			12537			12547			12538			12539		
	DEPTH_TOP	0			0			0			0			0		
	DEPTH_BOT	0.2			0.2			0.2			0.2			0.2		
	MATRIX	SOIL			SOIL			SOIL			SOIL			SOIL		
Parameter	Units	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error	Lab_Value	Lab_Qual	Lab_Error
Bismuth-214	pCi/g	1.7	J	0.5	2.6	J	0.4	1.3	J	0.3	1.5	UJ		1.8	J	0.5
Cesium-137	pCi/g	0.2	U		1.1	U		1	U		0.6	U		0.8	U	
Cobalt-57	pCi/g	0.1	U		0.1	U		0.2	U		0.1	U		0.1	U	
Cobalt-60	pCi/g	0.3	U		0.1	U		0.2	U		0.1	U		0.1	U	
Lead-210	pCi/g	5	U		3.9	U		23	U		25.9	U		3.7	U	
Lead-211	pCi/g	8.3	U		12.1	U		1.3	U		4.8	U		2.5	U	
Lead-214	pCi/g	2.5		0.5	2.4		0.6	1.3		0.3	1.2	U		1.4	U	
Moisture (@ 104 deg. C)	% by Wt	22.4			29.7			28.3			22.3			30.1		
Plutonium-239/240	pCi/g	0.2	UJ	0.2	0.3	UJ	0.1	0.2	U	0.1	0.2	U	0.2	0.2	U	0.1
Promethium 147	pCi/g	12.8		5.2	10.1	U	5.1	15.5		5.2	12		5.2	9.5	U	5.1
Radium-223	pCi/g	0.5	U		0.7		0.3	0.4	U		0.3	U		0.5	U	
Radium-226	pCi/g	1.7	J	0.5	2.6	J	0.4	1.3	J	0.3	1.5	UJ		1.8	J	0.5
Radium-228	pCi/g	2.1	J	0.7	2.2	J	0.6	2	J	0.5	1.2	J	0.4	1.4	J	0.4
Thorium-227	pCi/g	0.2	U	0.2	0.6	U	0.5	0.5	U	0.1	0.1	U	0.2	0.1	U	0.1
Thorium-230	pCi/g	1.6	J	0.6	0.5	UJ	0.7	0.6	UJ	0.6	0.5	UJ	0.6	1	UJ	0.6
Thorium-232	pCi/g	0.5		0.4	0.8		0.6	1.2		0.7	0.7		0.5	0.9		0.5
Tritium	pCi/g	0.8	J	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	UJ	0.1	0.1	UJ	0.1
Uranium-233/234	pCi/g	1.9	J	0.8	0.7	U	0.3	0.7		0.3	0.5	U	0.2	0.8		0.3
Uranium-235	pCi/g	0.3	J	0.3	0.1		0.1	0.2	U	0.1	0.1		0.1	0.1		0.1
Uranium-238	pCi/g	1.4	J	0.6	0.7	U	0.3	1		0.4	0.6	U	0.2	0.5	U	0.2

T
SENEC DEPOT
SOIL DATA
BACKGROUND RADIONULCIDE DATA SET

	LOC_ID	SS12-7			SS12-8			SS12-9			MW34/MW35			MW45-4		
	SAMP_ID	12540			12548			12546			12550			12551		
	DEPTH_TOP	0			0			0			1 5			2		
	DEPTH_BOT	0 2			0 2			0 2			2			2 5		
	MATRIX	SOIL			SOIL			SOIL								
Parameter	**Units**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**
Bismuth-214	pCi/g	1 4	J	0 5	1 6	J	0 5	2 5	UJ		1 5	J	0.4	1 3	UJ	
Cesium-137	pCi/g	0 2	U		0 4	U		1 1	U		0.4	U		0 3	U	
Cobalt-57	pCi/g	0 1	U		0 2	U		0 1	U		0 1	U		0 1	U	
Cobalt-60	pCi/g	0 1	U		0 1	U		0 4	U		0 3	U		0 2	U	
Lead-210	pCi/g	23 1	U		17 9	U		6 3	U		3 7	U		12 8	U	
Lead-211	pCi/g	5 8	U		9 9		3 8	21.5	U		8 7	U		1 4	U	
Lead-214	pCi/g	1 6		0 3	1 7		0 4	2 2		0 4	1.6		0.4	1.8		0 4
Moisture (@ 104 deg C)	% by Wt	28 2			36			32 7			15 8			13 6		
Plutonium-239/240	pCi/g	0 2	U	0 1	0 2	U	0 1	0 2	U	0 1	0 2	U	0 1	0.2	U	0 1
Promethium 147	pCi/g	16 8		6 3	12 4	U	5 2	11 5	U	5 2	10 3		5 1	8	U	5 1
Radium-223	pCi/g	0 5	U		0 5	U		0 4	U		0 5	U		0 3	U	
Radium-226	pCi/g	1 4	J	0 5	1 6	J	0 5	2 5	UJ		1 5	J	0 4	1.3	UJ	
Radium-228	pCi/g	1	J	0 4	2 5	J	0 6	2 3	UJ		2 6	J	0 7	2 1	J	0 4
Thorium-227	pCi/g	0 5	U	0 5	1 1	UJ	0 1	0 7	U	0 1	0.4	UJ	0.7	0 5	U	0 6
Thorium-230	pCi/g	1 4	UJ	0 9	1 2	UJ	1 3	1 5	UJ	1	0 9	UJ	1.1	0 6	UJ	0 6
Thorium-232	pCi/g	0 8		0 6	1 8	J	1 4	1		0 7	0 6	J	0 7	0 9		0 7
Tritium	pCi/g	0 1	UJ	0 1	0 1	UJ	0 1	9 6	J	0 2	0 1	UJ	0 1	0 1	UJ	0 1
Uranium-233/234	pCi/g	0 7	J	0 4	0 9		0 4	0 9		0 3	0 4	U	0 2	0.8		0 3
Uranium-235	pCi/g	0 3	J	0 3	0 1		0 1	0 2		0 1	0 1	U	0 1	0 1		0 1
Uranium-238	pCi/g	1	J	0 5	0 9		0.3	1		0.4	0.5	U	0.2	0 5	U	0 2

TABLE D-1
SENECA ARMY DEPOT
SOIL DATA
BACKGROUND RADIONULCIDE DATA SET

LOC_ID		MW57-1			SB12-9			SB12-8			SB12-7		
SAMP_ID		12549			123189			123193			123194		
DEPTH_TOP		2			0			0			0		
DEPTH_BOT		2.5			2			2			2		
MATRIX													
Parameter	**Units**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**	**Lab_Value**	**Lab_Qual**	**Lab_Error**
Bismuth-214	pCi/g	1.6	J	0.3	2.2		0.6	2.3		0.3	1.6		0.5
Cesium-137	pCi/g	0.5	U		0.1		0.1	0.5		0.1	0.2		0.1
Cobalt-57	pCi/g	0.1	U		0.1		0.1	0.1		0.1	0.1	U	
Cobalt-60	pCi/g	0.1	U		0.1		0.1	0.3		0.1	0.4		0.1
Lead-210	pCi/g	5.1	U		1.8	UJ		4	J	3.4	2.9	J	1.7
Lead-211	pCi/g	1.3	U		1.3	U		1.4	U		1.9	U	
Lead-214	pCi/g	1.4		0.4	1.9		0.4	1.7		0.4	1.5		0.3
Moisture (@ 104 deg C)	% by Wt	15.2			10.5			11.7			9.3		
Plutonium-239/240	pCi/g	0.1	UJ	0.2	0.1	U	0.1	0.1	U	0.2	0.1	U	
Promethium 147	pCi/g	11.4		5.2									
Radium-223	pCi/g	0.4	U		0.5	U		0.4	U		0.4	U	
Radium-226	pCi/g	1.6	J	0.3	2.2		0.6	2.3		0.3	1.6		0.5
Radium-228	pCi/g	2	J	0.5	1.3	J	0.4	2.6	J	0.5	1.8	J	0.4
Thorium-227	pCi/g	1.7	UJ	1.1									
Thorium-230	pCi/g	1.3	J	1	0.8	J	0.5	0.9	J	0.5	0.8	J	0.6
Thorium-232	pCi/g	1.3	J	1	0.7		0.4	0.7		0.4	1	J	0.6
Tritium	pCi/g	0.1	UJ	0.1	0.1	UJ		0.1	UJ		0.1	UJ	
Uranium-233/234	pCi/g	0.7		0.3	0.9		0.3	0.7		0.3	0.8		0.3
Uranium-235	pCi/g	0.2		0.2	0.1		0.1	0.1		0.1	0.1		0.1
Uranium-238	pCi/g	0.8		0.3	0.9		0.3	0.7		0.2	1.1		0.3

TABLE D-2
SENECA ARMY DEPOT
SURFACE WATER DATA
BACKGROUND RADIONULCIDE DATA SET

SITE:			SEAD-12			SEAD-12			SEAD-12	
LOCID			SWSD12-59			SWSD12-60			SWSD12-61	
SAMPID:			12053			12054			12055	
QCCODE:			SA			SA			SA	
SAMP.DETHTOP:			0			0			0	
SAMP DEPTHBOT:			0.1			0.1			0.1	
MATRIX:			SURFACEWATER			SURFACEWATER			SURFACEWATER	
SAMP.DATE:			10-Nov-97			10-Nov-97			11-Nov-97	
PARAMETER	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Bismuth-214	pCi/L	20.2		8.9	14.5		5	21.9		6
Cobalt-57	pCi/L	0.7	U		0.3	U		1	U	
Cobalt-60	pCi/L	4.9	U		4	U		0.5	U	
Cesium-137	pCi/L	5.9	U		6.2	U		0.7	U	
Tritium	pCi/L	158	J	184	63.1	J	180	113	UJ	176
Lead-211	pCi/L	16.1	U		196	U		464		220
Lead-214	pCi/L	15.2		6.8	15.5		4.9	32.6	U	
Plutonium-239/240	pCi/L	0.1	U	0.1	0.1	U	0.2	0.2	U	0.1
Radium-223	pCi/L	0.5	UJ		0.5	UJ		0.5	UJ	
Radium-226	pCi/L	0.5	UJ	0.2	0.5	UJ	0.2	0.5	UJ	0.2
Thorium-227	pCi/L	0.1		0.1	0.2	U	0.1	0.1		0.1
Thorium-230	pCi/L	0.1	U	0.2	0.4	U	0.3	0.2	U	0.2
Thorium-232	pCi/L	0.2	U	0.1	0.2	U	0.1	0.2	U	0.1
Uranium-233/234	pCi/L	0.5	U	0.3	0.8	U	0.3	0.3	U	0.2
Uranium-235	pCi/L	0.1		0.1	0.1		0.1	0.2	UJ	0.1
Uranium-238	pCi/L	0.1		0.1	0.1		0.1	0.1	U	0.2
GrossAlpha	pCi/L	1.4	U	0.8	0.4		1.1	2.5	U	1.4
GrossBeta	pCi/L	3.1	J	0.9	3.9	J	0.9	2.5	U	1.3
Promethium147	pCi/L	57.2		40.1	61.3		33.7	63.9	U	40.2
Radon222	pCi/L	51.3		37.2	36.7		37.1	66.9	U	33.1
Uranium-234	pCi/L		ND			ND			ND	

TABLE D-2
SENECA ARMY DEPOT
SURFACE WATER DATA
BACKGROUND RADIONULCIDE DATA SET

SITE:			SEAD-12			SEAD-12			SEAD-12	
LOCID:			SWSD12-63			SWSD12-63			SWSD12-64	
SAMPID:			12049			12048			12056	
QCCODE:			SA			SA			SA	
SAMP.DETHTOP:			0			0			0	
SAMP.DEPTHBOT:			0.1			0.2			0.1	
MATRIX:			SURFACEWATER			SURFACEWATER			SURFACEWATER	
SAMP.DATE:			10-Nov-97			9-Nov-97			11-Nov-97	
PARAMETER	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Bismuth-214	pCi/L	18		7.6	16.7		5.7	16.1		4.3
Cobalt-57	pCi/L	0.7	U		0.5	U		1.4	U	
Cobalt-60	pCi/L	0.4	U		3.2	U		0.5	U	
Cesium-137	pCi/L	2.9	U		2.4	U		1.5	U	
Tritium	pCi/L	289	UJ	169	13.5	J	181	286	UJ	167
Lead-211	pCi/L	219	U		22.9	U		279	U	
Lead-214	pCi/L	12.2	U		18.4	U		17.7	U	
Plutonium-239/240	pCi/L	0.2	U	0.2	0.3	U	0.1	0.2	U	0.1
Radium-223	pCi/L	0.5	UJ		0.5	UJ		0.5	UJ	
Radium-226	pCi/L	0.5	UJ	0.2	0.5	UJ	0.2	0.5	UJ	0.2
Thorium-227	pCi/L	0.1		0.1	0.2	U	0.1	0.2	U	0.1
Thorium-230	pCi/L	0.6	U	0.3	0.6	U	0.3	0.4	U	0.3
Thorium-232	pCi/L	0.2	U	0.1	0.1		0.1	0.3	U	0.1
Uranium-233/234	pCi/L	0.4	U	0.3	0.5	U	0.3	0.6	U	0.3
Uranium-235	pCi/L	0.1		0.1	0.1	U	0.1	0.1	J	0.1
Uranium-238	pCi/L	0.3		0.2	0.1	U	0.1	0.2	U	0.2
GrossAlpha	pCi/L	7.4		1.5	11.5		1.7	2.5	U	1.4
GrossBeta	pCi/L	27.4	J	1.4	23	J	1.4	2.9	U	1.5
Promethium147	pCi/L	69.8	U					70.6	U	33.8
Radon222	pCi/L	55.9		36.8	68.8		43.9	54.8	U	33.1
Uranium-234	pCi/L		ND			ND			ND	

TABLE D-2
SENECA ARMY DEPOT
SURFACE WATER DATA
BACKGROUND RADIONULCIDE DATA SET

SITE:			SEAD-12			SEAD-12			SEAD-12	
LOCID:			SWSD12-65			SWSD12-66			SWSD12-67	
SAMPID:			12057			12058			12047	
QCCODE:			SA			SA			SA	
SAMP.DETHTOP:			0			0			0	
SAMP.DEPTHBOT:			0 2			0.1			0.2	
MATRIX:			SURFACEWATER			SURFACEWATER			SURFACEWATER	
SAMP DATE:			11-Nov-97			11-Nov-97			9-Nov-97	
PARAMETER	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Bismuth-214	pCi/L	10.4		3.4	17.9		7.2	13 7		6.3
Cobalt-57	pCi/L	0.7	U		0.8	U		0.6	U	
Cobalt-60	pCi/L	2.8	U		8	U		2.9	U	
Cesium-137	pCi/L	3	U		1.9	U		4.5	U	
Tritium	pCi/L	153	UJ	177	58.6	UJ	173	113	J	186
Lead-211	pCi/L	9.3	U		269	U		13.8	U	
Lead-214	pCi/L	11.3	U	3.4	14.9	U	4.6	12.7		5.3
Plutonium-239/240	pCi/L	0.2	U	0.1	0.3	U	0.2	0.2	U	0.2
Radium-223	pCi/L	0.5	UJ		0.5	UJ		0.5	UJ	
Radium-226	pCi/L	0.5	UJ	0.2	0.5	UJ	0.2	0.5	UJ	0.2
Thorium-227	pCi/L	0.3	U	0.1	0.2	U	0.1	0.2	UJ	0.1
Thorium-230	pCi/L	0.3	U	0.2	0.2	U	0.2	0.4	UJ	0.3
Thorium-232	pCi/L	0.2	U	0.1	0.2	U	0 1	0 1	J	0.1
Uranium-233/234	pCi/L	0.4	U	0.2	0.5	U	0.3	0.3	U	0.2
Uranium-235	pCi/L	0.1	J	0 1	0.1	J	0.1	0.1	U	0.1
Uranium-238	pCi/L	0.4	U	0 2	0 2	U	0.1	0.2		0.2
GrossAlpha	pCi/L	2.7	U	1.5	2.5	U	1.5	7.6		1.5
GrossBeta	pCi/L	2 5	U	1 3	2 2	U	1 2	23.7	J	1.1
Promethium147	pCi/L	55.1	U	33 6	49.1	U	40			
Radon222	pCi/L	57.5	U	33 4	82.3	U	33 9	41 7		43.4
Uranium-234	pCi/L		ND			ND			ND	

TABLE D-3
SENECA ARMY DEPOT
SEDIMENT DATA
BACKGROUND RADIONULCIDE DATA SET

SITE:			SEAD-12			SEAD-12			SEAD-12	
LOC ID:			SWSD12-59			SWSD12-60			SWSD12-61	
SAMP ID:			12453			12454			12455	
QC CODE:			SA			SA			SA	
SAMP. DETH TOP:			0.8			1			0.7	
SAMP. DEPTH BOT:			1			1.2			0.9	
MATRIX:			SEDIMENT			SEDIMENT			SEDIMENT	
SAMP. DATE:			10-Nov-97			10-Nov-97			11-Nov-97	
PARAMETER	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/g		C.N		.4	U		.4	U	
Bismuth-214	pCi/g	2		0.5	2.2	UJ		1.1	J	0.3
Cobalt-57	pCi/g	.1	U		.1	UJ		.1	U	
Cobalt-60	pCi/g	.1	U		.1	UJ		.1	U	
Cesium-137	pCi/g	.1	U		.5	UJ		.1	U	
Tritium	pCi/g	.1	UJ	0.1	.1	J	0.1	.1	UJ	0.1
Lead-210	pCi/g	6.1	U		18.1	UJ		13.	U	
Lead-211	pCi/g	12.3	U		12.5	UJ		4.5	U	
Lead-214	pCi/g	.4	U		1.9	J	0.4	1.3		0.3
Plutonium-239/240	pCi/g	.1	U	0.1	.1	J	0.1	.4	UJ	0.1
Radium-223	pCi/g	.5	U		.6	U		.3	U	
Radium-226	pCi/g	2.		0.5	2.2	U		1.1	J	0.3
Thorium-227	pCi/g		C.N		.4	U	0.1	.4	U	0.1
Thorium-230	pCi/g	.9	J	0.8	1.4	J	0.8	1.6	UJ	0.8
Thorium-232	pCi/g	1.7	J	1	1.3	J	0.7	1.1	J	0.6
Uranium-233/234	pCi/g	.8		0.3	.6	UJ	0.2	.7		0.3
Uranium-235	pCi/g	.2		0.1	.1	J	0.1	.1	U	0.1
Uranium-238	pCi/g	.6	U	0.2	.6	UJ	0.2	.8		0.3
Radium-228	pCi/g	2.4	U		2.	J	0.7	2.1	J	0.5
Promethium 147	pCi/g	7.		5.2	11.6	J	5.3	3.7		5.1
Moisture (@ 104 deg. C)	% by Wt	26.5			67.3			16.4		

TABLE D-3
SENECA ARMY DEPOT
SEDIMENT DATA
BACKGROUND RADIONULCIDE DATA SET

SITE:			SEAD-12			SEAD-12			SEAD-12	
LOC ID:			SWSD12-63			SWSD12-63			SWSD12-64	
SAMP ID:			12448			12449			12456	
QC CODE:			SA			SA			SA	
SAMP. DETH TOP:			0.2			0.3			0.6	
SAMP. DEPTH BOT:			0.4			0.5			0.8	
MATRIX:			SEDIMENT			SEDIMENT			SEDIMENT	
SAMP. DATE:			9-Nov-97			10-Nov-97			11-Nov-97	
PARAMETER	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/g	.1	J		.1	J		.6	J	
Bismuth-214	pCi/g	1.4	U		1.8	J	0.5	1.4	J	0.3
Cobalt-57	pCi/g	.1	U		.1	UJ		.1	UJ	
Cobalt-60	pCi/g	.2	U		.3	UJ		.3	UJ	
Cesium-137	pCi/g	.6		0.2	.4	UJ		.3	UJ	
Tritium	pCi/g	.1	UJ	0.1	.2	J	0.1	.2	U	0.1
Lead-210	pCi/g	4.6	U		27.1	UJ		19.3	UJ	
Lead-211	pCi/g	2.5	U		5.5	UJ		5.7	UJ	
Lead-214	pCi/g	2.1		0.5	1.7	J	0.5	1.8	J	0.3
Plutonium-239/240	pCi/g	.1		0.1	.1	UJ	0.1	.1	UJ	0.2
Radium-223	pCi/g	.4	U		.5	UJ		.5	UJ	
Radium-226	pCi/g	1.4	U		1.8	J	0.5	1.4	J	0.3
Thorium-227	pCi/g	.1	J	0.2	.1	J	0.2	.6	J	0.5
Thorium-230	pCi/g	1.2	J	0.7	.7	UJ	0.4	1.5	UJ	0.7
Thorium-232	pCi/g	1.	J	0.6	1.	J	0.5	.8	J	0.5
Uranium-233/234	pCi/g	.6	U	0.2	.7	UJ	0.3	.9	UJ	0.5
Uranium-235	pCi/g	.1	U	0.1	.1	J	0.1	.6	UJ	0.4
Uranium-238	pCi/g	.5	U	0.2	.6	UJ	0.2	.6	UJ	0.4
Radium-228	pCi/g	1.9		0.4	2.3	J	0.5	1.4	J	0.5
Promethium 147	pCi/g	15.8		5.3	12.	J	5.3	16.3	J	5.3
Moisture (@ 104 deg. C)	% by Wt	48.4			54.5			68.		

TABLE D-3
SENECA ARMY DEPOT
SEDIMENT DATA
BACKGROUND RADIONULCIDE DATA SET

SITE:			SEAD-12			SEAD-12			SEAD-12	
LOC ID:			SWSD12-65			SWSD12-66			SWSD12-67	
SAMP ID:			12457			12458			12447	
QC CODE:			SA			SA			SA	
SAMP. DETH TOP:			0.2			2.5			0.2	
SAMP. DEPTH BOT:			0.5			2.8			0.4	
MATRIX:			SEDIMENT			SEDIMENT			SEDIMENT	
SAMP. DATE:			11-Nov-97			11-Nov-97			9-Nov-97	
PARAMETER	UNIT	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR	VALUE	QUAL	ERROR
Actinium-227	pCi/g	.6	J		.1			.1	J	
Bismuth-214	pCi/g	1.3		0.4	1.7	UJ		2	J	0.4
Cobalt-57	pCi/g	.2	UJ		.2	U		.1	UJ	
Cobalt-60	pCi/g	.1	UJ		.3	U		.1	UJ	
Cesium-137	pCi/g	.5	UJ		.3	U		.5	UJ	
Tritium	pCi/g	.2	UJ	0.1	.1	UJ	0.1	.1	UJ	0.1
Lead-210	pCi/g	37.	UJ		14.9	U		28.4	UJ	
Lead-211	pCi/g	2.1	UJ		1.5	U		10.2	UJ	
Lead-214	pCi/g	1.6	J	0.4	1.3		0.3	2.	J	0.4
Plutonium-239/240	pCi/g	.3	UJ	0.1	.3	UJ	0.2	.2	UJ	0.1
Radium-223	pCi/g	.5	UJ		.4	UJ		.5	U	
Radium-226	pCi/g	1.3	J	0.4	1.7	U		2.	J	0.4
Thorium-227	pCi/g	.6	J	0.6	.1		0.2	.1	J	0.1
Thorium-230	pCi/g	1.5	UJ	1	2.3	UJ	1.1	.9	UJ	0.5
Thorium-232	pCi/g	1.9	J	1	1.4	J	0.8	1.4	J	0.7
Uranium-233/234	pCi/g	1.1	UJ	0.4	.9		0.4	.5	UJ	0.2
Uranium-235	pCi/g	.4	UJ	0.2	.2	U	0.1	.1	UJ	0.1
Uranium-238	pCi/g	.7	UJ	0.3	.6	U	0.3	.4	UJ	0.2
Radium-228	pCi/g	2.4	J	0.6	1.4	J	0.4	1.6	J	0.4
Promethium 147	pCi/g	14.3	J	5.3	10.2		5.2	13.5	J	5.3
Moisture (@ 104 deg. C)	% by Wt	64.6			26.6			60.5		

TABLE D-4
SENECA ARMY DEPOT
GROUNDWATER DATA
BACKGROUND GROSS ALPHA/GROSS BETA DATA SET

Samp ID		122000		122029		122033		122034		122035		122036		122037		122042		122001	
Location ID		MW45-4		MW57-1		MW12-1		MW12-2		MW12-3		MW12-4		MW12-5		MW12-6		MW-34	
QC Code		SA		SA		SA		SA		SA		SA		SA		SA		SA	
Sample Date		04/09/99	ERR	04/23/99	ERR	04/25/99	ERR	04/25/99	ERR	04/25/99	ERR	04/25/99	ERR	04/25/99	ERR	05/04/99	ERR	04/09/99	ERR
Gross Alpha	pCi/L	0.3	1.9	1.2 U	0.7	0.5	1.6	2.2 U	1.4	5.7	1.8	3.6 U	2.2	2.5	2.3	1.8	2	1	1
Gross Beta	pCi/L	3.3	1.5	2.1	0.6	1.8	1.3	1	1.3	6.3	1.4	2.6	1.9	12.6	2.1	1.6	2.7	2.6	0.6
Conductivity	umhos	872		303		594		557		625		857		933		843		441	
Turbidity	NTU	0		12		4.3		23		18		40		18		16.8		9.6	

CHEMICAL INORGANIC BACKGROUND DATA

TABLE D-5: SOIL
TABLE D-6: GROUNDWATER

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								B-8-91		B-8-91		B-8-91		B-8-91		B-9-91		B-9-91	
QC CODE								SA		SA		SA		SA		SA		SA	
STUDY ID								RI PHASE1		RI PHASE1		RI PHASE1		RI PHASE1		RI PHASE1		RI PHASE1	
TOP																			
BOTTOM																			
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE								11/5/1991		11/5/1991		11/5/1991		11/5/1991		11/5/1991		11/5/1991	
SAMP ID.								S1105-24SOIL1		S1105-25SOIL1		S1105-26(1)SOIL1		S1105-27SOIL1		S1105-28SOIL1		S1105-29SOIL1	
COMPOUND	UNIT	MAXIMUM	FREQUENCY OF DETECTION	TAGM	NUMBER ABOVE TAGM	NUMBER OF DETECTS	NUMBER OF ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	19200		[illegible]		17700		12700		14800		8880	
Antimony	MG/KG	6 8	18%	6	2	10	57	10 3	UJ	8 8	UJ	8.2	UJ	8.4	UJ	9.9	UJ	9 9	UJ
Arsenic	MG/KG	21 5	95%	8 9	2	54	57	5 1	J	6 1	J	6	J	4 2	J	4 3	J	3.8	J
Barium	MG/KG	159	100%	300	0	57	57	136	J	98 9	J	86.7	J	56.2	J	101	J	110	J
Beryllium	MG/KG	1 4	100%	1.13	2	57	57	[illegible]		[illegible]		1		0.78	J	1.1		0.76	
Cadmium	MG/KG	2 9	35%	2.46	2	20	57	[illegible]		[illegible]		2 4		1.9		2 3		1.7	
Calcium	MG/KG	293000	100%	125300	2	57	57	5390		4870		3560		85900		45600		104000	
Chromium	MG/KG	32.7	100%	30	2	57	57	27 4	J	[illegible]	J	26.9	J	19.8	J	22.5	J	13 8	J
Cobalt	MG/KG	29 1	100%	30	0	57	57	13 8		18.4		14		14.2		13.7		10.7	
Copper	MG/KG	62 8	100%	33	3	57	57	22 3		27 6		28		18 2		22 6		21 6	
Cyanide	MG/KG	0	0%	0 35	0	0	51	0 6	U	0.63	U	0 67	U	0.58	U	0 7	U	0.63	U
Iron	MG/KG	38600	100%	37410	2	57	57	37200		36100		32500		27400		31000		19600	
Lead	MG/KG	266	95%	24 4	3	54	57	14 5		11.4		13 6		10.1		10 8		10 1	
Magnesium	MG/KG	29100	100%	21700	2	54	54	5850		7300		6490		6720		8860		17000	
Manganese	MG/KG	2380	95%	1100	2	54	57	[illegible]		956		832		926		903		532	
Mercury	MG/KG	0.13	72%	0 1	2	41	57	0.09		0 06	J	0.06	J	0 05	J	0 08	J	0 04	J
Nickel	MG/KG	62.3	98%	50	2	56	57	42 3		48.7		44 4		30.4		38 4		23.8	
Potassium	MG/KG	3160	100%	2623	2	57	57	1910		2110		1760		1430		1320		1080	
Selenium	MG/KG	1 7	40%	2	0	23	57	0 17	UJ	0 21	UJ	0 2	UJ	0 61	UJ	0 21	UJ	0 65	UJ
Silver	MG/KG	0 87	4%	0 8	1	2	54	1 6	U	1 3	U	1 2	U	1 3	U	1 5	U	1 5	U
Sodium	MG/KG	269	82%	188	2	47	57	79 2	U	67 5	U	62 8	U	75.3	J	84 2	J	112	J
Thallium	MG/KG	1 2	17%	0 865	3	9	54	0 47	U	0 58	U	0 57	U	0 34	U	0 59	U	0 38	U
Vanadrum	MG/KG	32 7	100%	150	0	57	57	32 2		25 4		26 4		15 7		19 7		19 5	
Zinc	MG/KG	126	95%	115	2	54	57	85 1	J	94 2	J	85	J	75	J	[illegible]	J	84 3	J

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								B-9-91		BK-1		BK-2		GB35		GB35		GB35	
QC CODE								SA		SA		SA		SA		SA		DU	
STUDY ID								RI PHASE1		RI PHASE1		RI PHASE1		RI PHASE1		RI PHASE1		RI PHASE1	
TOP																			
BOTTOM																			
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE:			FREQUENCY		NUMBER	NUMBER	NUMBER	11/5/1991		12/16/1992		12/16/1992		1/20/1993		1/20/1993		1/20/1993	
SAMP ID			OF		ABOVE	OF	OF	S1105-30RESOIL1		BK-1SOIL3		BK-2RESOIL3		GB35-1GRID		GB35-2GRID		GB35-6DUGRID	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	7160		19400		14400		18000		17600		16200	
Antimony	MG/KG	6.8	18%	8	2	10	57	7	UJ	7.9	U	7.2	U	5.8	UJ	[illegible]	J	[illegible]	J
Arsenic	MG/KG	21.5	95%	8.9	2	54	57	4.4	J	3		2.7		6.2		7.7		5.3	
Barium	MG/KG	159	100%	300	0	57	57	39.9	J	159		106		93.6		61.7		61.7	
Beryllium	MG/KG	1.4	100%	1.13	2	57	57	0.52	J	1.1		0.81		0.85		0.74		0.77	
Cadmium	MG/KG	2.9	35%	2.46	2	20	57	1.5		0.45	U	0.41	U	0.33	U	0.31	U	0.35	U
Calcium	MG/KG	293000	100%	125300	2	57	57	101000		4590		22500		1590		17700		1370	
Chromium	MG/KG	32.7	100%	30	2	57	57	11.2	J	30		22.3		23.5		29.3		25.1	
Cobalt	MG/KG	29.1	100%	30	0	57	57	8.1		14.4		12.3		9.4		16.3		10.3	
Copper	MG/KG	62.8	100%	33	3	57	57	19.3		26.9		18.8		17.5		24.5		17.2	
Cyanide	MG/KG	0	0%	0.35	0	0	51	0.62	U	0.57	U	0.61	U	0.78	U	0.71	U	0.82	U
Iron	MG/KG	38600	100%	37410	2	57	57	17300		[illegible]		26600		25200		34200		30800	
Lead	MG/KG	266	95%	24.4	3	54	57	7.8		15.8		18.9		14.4		5.4		19.1	
Magnesium	MG/KG	29100	100%	21700	2	54	54	12600		5980		7910		3850		7790		4490	
Manganese	MG/KG	2380	95%	1100	2	54	57	514		[illegible]		800		701		646		775	
Mercury	MG/KG	0.13	72%	0.1	2	41	57	0.05	J	[illegible]	J	[illegible]		0.06	J	0.03	U	0.07	J
Nickel	MG/KG	62.3	98%	50	2	56	57	19		47.7		31		26.3		48.7		28.3	
Potassium	MG/KG	3160	100%	2623	2	57	57	1050		1720		1210		1110		1110		975	
Selenium	MG/KG	1.7	40%	2	0	23	57	0.21	UJ	0.73	J	0.94		0.23	UJ	0.23	UJ	0.21	UJ
Silver	MG/KG	0.87	4%	0.8	1	2	54	1.1	U	0.47	U	0.43	U	0.34	U	0.32	U	0.36	U
Sodium	MG/KG	269	82%	188	2	47	57	116	J	49.1	J	61.1	J	35.6	J	77.5	J	34.6	J
Thallium	MG/KG	1.2	17%	0.655	3	9	54	0.6	U	0.42	U	0.38	U	0.55	U	0.54	U	0.5	U
Vanadium	MG/KG	32.7	100%	150	0	57	57	12.9		28		22.4		27.1		22.3		26.1	
Zinc	MG/KG	126	95%	115	2	54	57	74.8	J	98.8		83.7		55		83.4		53.1	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								GB36		GB36		MW-36		MW-34		SB24-5		SB24-5	
QC CODE								SA		SA		SA		SA		SA		SA	
STUDY ID								RI PHASE1		RI PHASE1		RI Phase 1 Step 1		RI PHASE1		ESI		ESI	
TOP												-1				-1		-1	
BOTTOM												-1				-1		-1	
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE			FREQUENCY		NUMBER	NUMBER	NUMBER	1/20/1993		1/20/1993		11-Jan-93		11/20/1991		12/02/93		12/02/93	
SAMP ID			OF		ABOVE	OF	OF	GB36-1GRID		GB36-2GRID		MW36-3GRID		S2011121MW34GRID		SB24-5-1		SB24-5-3	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	18100		16200		12700		16100		16200		10100	
Antimony	MG/KG	6 8	18%	6	2	10	57	5 9	J	5.8	UJ	5.7	UJ	5 7	J	12.5	UJ	5 8	UJ
Arsenic	MG/KG	21 5	95%	8 9	2	54	57	4 6		[illegible]		2 9	J	6 3	U	4 2		3 3	
Barium	MG/KG	159	100%	300	0	57	57	74 8		50.8		46.9	J	67 5		117		58 3	
Beryllium	MG/KG	1.4	100%	1 13	2	57	57	0 77		0.65		0 59		0 86		0.98	J	0 48	J
Cadmium	MG/KG	2 9	35%	2 46	2	20	57	0 3	U	0 33	U	0 33	U	2 3		0 78	U	0 36	U
Calcium	MG/KG	293000	100%	125300	2	57	57	1660		22900		4170		28600		4540		74200	
Chromium	MG/KG	32.7	100%	30	2	57	57	24 8		27 4		23 3	J	26 6		24 5		16 9	
Cobalt	MG/KG	29 1	100%	30	0	57	57	20 4		13 2		16 6		17		16		8 2	
Copper	MG/KG	62 8	100%	33	3	57	57	17 7		17 5		19 2	J	32 7		28 4		20 9	
Cyanide	MG/KG	0	0%	0 35	0	0	51	0 7	U	0 68	U	0 56	U	0 54	U	0 6	U	0 51	U
Iron	MG/KG	38600	100%	37410	2	57	57	26100		30700		27500		35000		33600		21300	
Lead	MG/KG	266	95%	24 4	3	54	57	12 7		6 2		20 2		11 9		[illegible]	J	8 7	J
Magnesium	MG/KG	29100	100%	21700	2	54	54	4490		7150		5750		6850		5150		12100	
Manganese	MG/KG	2380	95%	1100	2	54	57	426		507		540		803		1080		400	
Mercury	MG/KG	0.13	72%	0 1	2	41	57	0.02	J	0 02	J	0 02	J	0.07	R	0 07	JR	0 06	JR
Nickel	MG/KG	62.3	98%	50	2	56	57	28 3		42 8		43 3	J	49 3	J	37.3		26.4	
Potassium	MG/KG	3160	100%	2623	2	57	57	1400		1100		754		1290		1170	J	993	
Selenium	MG/KG	1 7	40%	2	0	23	57	0 2	UJ	0 16	UJ	0 19	UJ	0.18	UJ	0 15	UJ	0 23	UJ
Silver	MG/KG	0 87	4%	0 8	1	2	54	0 31	U	0 34	U	0 34	U	[illegible]	J	1 6	U	0 73	U
Sodium	MG/KG	269	82%	188	2	47	57	46 6	J	97 6	J	31 6	U	55 2	J	50 9	J	153	J
Thallium	MG/KG	1 2	17%	0 855	3	9	54	0 46	U	0 43	U	0 45	U	0 51	U	0 16	U	0 25	U
Vanadium	MG/KG	32 7	100%	150	0	57	57	27 8		19 7		16 2	J	22 3		29 9		14 4	
Zinc	MG/KG	126	95%	115	2	54	57	59 2		74 1		34 7	J	95 7		65.7		62 8	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								SB24-5		MW25-1		MW25-1		MW25-6		MW25-6		MW25-6	
QC CODE								SA		SA		SA		SA		SA		SA	
STUDY ID								ESI		ESI		ESI		RI ROUND1		RI ROUND1		RI ROUND1	
TOP								-1		0		2		0		4		6	
BOTTOM								-1		2		4		0 17		6		8	
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE.			FREQUENCY		NUMBER	NUMBER	NUMBER	12/02/93		12/3/1993		12/3/1993		9/25/1995		9/25/1995		9/25/1995	
SAMP ID			OF		ABOVE	OF	OF	SB24-5-5		SB25-6-01		SB25-6-02		SB25-7-00		SB25-7-03		SB25-7-04	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	13700		10600		7070		12500		8020		7550	
Antimony	MG/KG	6 8	16%	8	2	10	57	11.3	UJ	4 2	U	3	U	0.4		0 42	UJ	0 44	U
Arsenic	MG/KG	21.5	95%	8 9	2	54	57	5		8 3		4 8		4.3		4.1		3 4	
Barium	MG/KG	169	100%	300	0	57	57	67 2		59 1		35		71.3		58		52	
Beryllium	MG/KG	1.4	100%	1.13	2	57	57	0 62	J	0 48	J	0 35	J	0.56		0.43		0 39	
Cadmium	MG/KG	2.9	35%	2 46	2	20	57	0 7	U	0 41	U	0.29	U	0 05	U	0.06	U	0.06	U
Calcium	MG/KG	293000	100%	125300	2	57	57	49000		82500		122000		47400	J	120000	J	[illegible]	J
Chromium	MG/KG	32.7	100%	30	2	57	57	23 1		16 9		11 3		16 9	J	13.7	J	12 4	J
Cobalt	MG/KG	29 1	100%	30	0	57	57	12		11 2		6 6	J	8		8.2		6 9	
Copper	MG/KG	62.8	100%	33	3	57	57	22 2		20 2	J	12	J	15.7		17.7		16 4	
Cyanide	MG/KG	0	0%	0 35	0	0	51	0 57	U	0 58	U	0 64	U	0 44	U	0 57	U	0 51	U
Iron	MG/KG	38600	100%	37410	2	57	57	26700		21400		15800		20500		18900		15400	
Lead	MG/KG	266	95%	24 4	3	54	57	7 9	J	9 5		13.8		11 1		7		6 5	
Magnesium	MG/KG	29100	100%	21700	2	54	54	11400		19600		[illegible]		11700		17400		20700	
Manganese	MG/KG	2380	95%	1100	2	54	57	450		722	J	610	J	452		735		402	
Mercury	MG/KG	0.13	72%	0 1	2	41	57	0 04	JR	0 03	J	0.04	U	0 03		0 02		0 01	
Nickel	MG/KG	62 3	98%	50	2	56	57	35 2		26 8		18		22 3		26.4		22 4	
Potassium	MG/KG	3180	100%	2623	2	57	57	1660		1480		1060		1110		1280		1430	
Selenium	MG/KG	1 7	40%	2	0	23	57	0 22	UJ	0 97	J	0 63	J	0 63	U	0.7	U	0 74	U
Silver	MG/KG	0 87	4%	0 8	1	2	54	1 4	U	0.62	U	0 59	U	0 89	U	0 98	U	1	U
Sodium	MG/KG	269	82%	188	2	47	57	139	J	[illegible]	J	186	J	59.9		89.1		110	
Thallium	MG/KG	1 2	17%	0 855	3	9	54	0 24	U	0 24	UJ	0 21	UJ	[illegible]		[illegible]		0 6	U
Vanadium	MG/KG	32 7	100%	150	0	57	57	19 5		18 5		12		21		13 4		13 7	
Zinc	MG/KG	126	95%	115	2	54	57	63 2		71 6	J	40 6	J	54.1		64.9		65 1	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								MW25-6		MW64A-1		MW64A-1		MW64A-1		MW64B-1		MW64B-1	
QC CODE								DU		SA		SA		SA		SA		SA	
STUDY ID								RI ROUND1		ESI		ESI		ESI		ESI		ESI	
TOP								0		0		2		4		0		4	
BOTTOM								0.17		0.2		4		6		0.2		6	
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE			FREQUENCY		NUMBER	NUMBER	NUMBER	9/25/1995		4/2/1994		4/2/1994		4/2/1994		5/13/1994		5/13/1994	
SAMP ID			OF		ABOVE	OF	OF	SB25-7-10		MW64A-1-1		MW64A-1-2		MW64A-1-3		MW64B-1-1		MW64B-1-2	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	12500		16100		[illegible]		12600		13400		8870	
Antimony	MG/KG	6.6	18%	6	2	10	57	0.4	UJ	0.23	J	0.2	UJ	0.2	UJ	0.3	J	0.18	UJ
Arsenic	MG/KG	21.5	95%	8.9	2	54	57	4.3		7.1		8.2		5		5.5		4.3	
Barium	MG/KG	159	100%	300	0	57	57	71.3		83.7		91.2		62.3		75.5		70.8	
Beryllium	MG/KG	1.4	100%	1.13	2	57	57	0.56		0.68	J	0.74	J	0.53	J	0.56	J	0.43	J
Cadmium	MG/KG	2.9	35%	2.46	2	20	57	0.05	U	0.11	J	0.02	U	0.12	J	0.63	J	0.64	J
Calcium	MG/KG	293000	100%	125300	2	57	57	47400	J	7210		4300		72400		5530		70000	
Chromium	MG/KG	32.7	100%	30	2	57	57	16.9	J	23		25		19		17.5		14.1	
Cobalt	MG/KG	29.1	100%	30	0	57	57	8		11.8		11.3		9.1	J	7.2	J	10	
Copper	MG/KG	62.8	100%	33	3	57	57	15.7		25.5		21		23.7		18.9		20.2	
Cyanide	MG/KG	0	0%	0.35	0	0	51	0.444	U	0.66	U	0.56	U	0.55	U	0.6	U	0.5	U
Iron	MG/KG	38600	100%	37410	2	57	57	20500		28500		28000		22600		20900		18400	
Lead	MG/KG	266	95%	24.4	3	54	57	11.1		21.6		13.6		15.4		21.4		8.8	
Magnesium	MG/KG	29100	100%	21700	2	54	54	11700		5480		5010		14800		3720		18900	
Manganese	MG/KG	2380	95%	1100	2	54	57	452		558		604		402		207		434	
Mercury	MG/KG	0.13	72%	0.1	2	41	57	0.03		0.05	J	0.03	J	0.02	J	0.05	J	0.02	J
Nickel	MG/KG	62.3	98%	50	2	56	57	22.3		32.2		28.6		26.7		19.8		28.2	
Potassium	MG/KG	3160	100%	2623	2	57	57	1110		2590	J	2260	J	[illegible]	J	1700		1630	
Selenium	MG/KG	1.7	40%	2	0	23	57	0.66	U	0.96		1.7		0.34	U	0.99	J	0.26	U
Silver	MG/KG	0.87	4%	0.8	1	2	54	0.92	U	0.12	U	0.14	U	0.14	U	0.16	UJ	0.11	UJ
Sodium	MG/KG	269	82%	188	2	47	57	57.5		27.5	U	31.8	U	92.1	J	35.9	U	96.8	J
Thallium	MG/KG	1.2	17%	0.655	3	9	54	[illegible]		0.42	J	0.32	U	0.32	U	0.41	J	0.24	U
Vanadium	MG/KG	32.7	100%	150	0	57	57	21		27.6		32.2		22.8		23.3		14.8	
Zinc	MG/KG	126	95%	115	2	54	57	54.1		104		87.1		64.9		72.2		59	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								MW64B-1		MW64B-1		MW67-2		MW67-2		MW67-2		MW70-1	
QC CODE								SA		SA		SA		SA		SA		SA	
STUDY ID								ESI		ESI		ESI		ESI		ESI		ESI	
TOP								6		6		0		2		4		0	
BOTTOM								8		8		0.2		4		5		0.2	
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE			FREQUENCY		NUMBER	NUMBER	NUMBER	5/13/1994		13-May-94		3/30/1994		3/30/1994		3/30/1994		5/11/1994	
SAMP ID			OF		ABOVE	OF	OF	MW64B-1-3		MW64B-1-04		MW67-2-1		MW67-2-2		MW67-2-3		MW70-1-1	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	7620		7620		16700		14900		9460		12200	
Antimony	MG/KG	6.8	18%	6	2	10	57	0.15	UJ	0.15	UJ	0.27	J	0.22	J	0.2	UJ	0.23	UJ
Arsenic	MG/KG	21.5	95%	8.9	2	54	57	5.5		5.5		4.4		4.5		4.2		5.4	
Barium	MG/KG	159	100%	300	0	57	57	76.7		76.7		114		105		80.8		67.5	
Beryllium	MG/KG	1.4	100%	1.13	2	57	57	0.37	J	0.37	J	0.67	J	0.61	J	0.4	J	0.44	J
Cadmium	MG/KG	2.9	35%	2.46	2	20	57	0.54	J	0.54	J	0.2	J	0.11	J	0.12	J	0.57	J
Calcium	MG/KG	293000	100%	125300	2	57	57	75900		75900		3580		79000		77800		3600	
Chromium	MG/KG	32.7	100%	30	2	57	57	13.5		13.5		19.5		22.5		14.8		13.7	
Cobalt	MG/KG	29.1	100%	30	0	57	57	7.4	J	7.4	J	7.5	J	10.4	J	9.7	J	5.5	J
Copper	MG/KG	62.8	100%	33	3	57	57	17.6		17.6		16.5		20.3		20.5		12.4	
Cyanide	MG/KG	0	0%	0.35	0	0	51	0.48	U	0.48	U	0.64	U	0.5	U	0.54	U		
Iron	MG/KG	38600	100%	37410	2	57	57	17100		17100		20500		24400		18700		17700	
Lead	MG/KG	266	95%	24.4	3	54	57	8.3		8.3		17.5		9.3		8.5		20.7	
Magnesium	MG/KG	29100	100%	21700	2	54	54	21500		21500								2830	
Manganese	MG/KG	2380	95%	1100	2	54	57	389		389		438		528		411		233	
Mercury	MG/KG	0.13	72%	0.1	2	41	57	0.01	U	0.01	U	0.04		0.01	J	0.02	J	0.1	J
Nickel	MG/KG	62.3	98%	50	2	56	57	22.6		22.6		18.7		32.3		25.9		12.3	
Potassium	MG/KG	3160	100%	2623	2	57	57	1650		1650		1780	J	[illegible]	J	1970	J	982	J
Selenium	MG/KG	1.7	40%	2	0	23	57	0.57	J	0.57	J	0.81		0.36	U	0.34	U	1	J
Silver	MG/KG	0.87	4%	0.8	1	2	54	0.11	UJ	0.11	UJ	0.11	U	0.15	U	0.14	U		
Sodium	MG/KG	269	82%	188	2	47	57	79.6	J	79.6	J	25.1	U	112	J	107	J	36.4	U
Thallium	MG/KG	1.2	17%	0.855	3	9	54	0.24	U	0.24	U	0.48	J	0.34	U	0.32	U		
Vanadium	MG/KG	32.7	100%	150	0	57	57	14.2		14.2		28.2		24.8		16.5		23.3	
Zinc	MG/KG	126	95%	115	2	54	57	45.6		45.600		64.8		62		60.1		55.4	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								MW70-1		MW70-1		SB11-3		SB11-3		SB11-3		SB13-1	
QC CODE								SA		SA		SA		SA		SA		SA	
STUDY ID								ESI		ESI		ESI		ESI		ESI		ESI	
TOP								2		4		0		2		10		0	
BOTTOM								4		6		2		4		12		2	
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE			FREQUENCY		NUMBER	NUMBER	NUMBER	5/11/1994		5/11/1994		11/2/1993		11/2/1993		11/3/1993		12/8/1993	
SAMP ID			OF		ABOVE	OF	OF	MW70-1-2		MW70-1-3		SB11-3-1		SB11-3-2		SB11-3-6		SB13-1-1	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	9480		11000		17600		6330		10900		18300	
Antimony	MG/KG	6 8	18%	6	2	10	57	0 21	UJ	0.19	UJ	10 8	UJ	8	UJ	7.6	UJ	5.1	J
Arsenic	MG/KG	21 5	95%	8.9	2	54	57	4.1		5.7		5.6		0		0		7	
Barium	MG/KG	159	100%	300	0	57	57	56 6		79.9		113		57.4		62.7		106	
Beryllium	MG/KG	1 4	100%	1 13	2	57	57	0 41	J	0 54	J	0 85	J	0 34	J	0.47	J	0 92	J
Cadmium	MG/KG	2 9	35%	2 46	2	20	57	0 43	J	0 8	J	0.67	U	0 5	U	0.48	U	0.45	U
Calcium	MG/KG	293000	100%	125300	2	57	57	51600		48600		4950		91300		48600		3570	
Chromium	MG/KG	32 7	100%	30	2	57	57	14 7		17.8		24		11 1		18.6		29.4	
Cobalt	MG/KG	29 1	100%	30	0	57	57	7 1	J	21		11.3		6.5	J	10.1		12	
Copper	MG/KG	62 8	100%	33	3	57	57	19.7		[illegible]		20		12 2		21.7		11.6	
Cyanide	MG/KG	0	0%	0 35	0	0	51					0.57	U	0.47	U	0 53	U	0 61	U
Iron	MG/KG	38600	100%	37410	2	57	57	16000		26400		27200		13200		26300		32500	
Lead	MG/KG	266	95%	24 4	3	54	57	9 1		13.6		[illegible]		11 4		10 1		15	
Magnesium	MG/KG	29100	100%	21700	2	54	54	13600		7980		4160		12900		10100		5890	
Manganese	MG/KG	2380	95%	1100	2	54	57	470		1040		674		356		434		451	
Mercury	MG/KG	0.13	72%	0 1	2	41	57	0 03	J	0 02	J	0 05	J	0 04	U	0.03	U	0 03	J
Nickel	MG/KG	62 3	98%	50	2	56	57	17 6		[illegible]		28.3		16 7		29 5		34 9	
Potassium	MG/KG	3160	100%	2623	2	57	57	1590		1350		2110		1110		1230		2190	
Selenium	MG/KG	1 7	40%	2	0	23	57	0 64	J	0.32	U	0 24	J	0.13	UJ	0 21	UJ	0 26	J
Silver	MG/KG	0 87	4%	0 8	1	2	54					1 4	UJ	1	UJ	0 97	UJ	0 9	U
Sodium	MG/KG	269	82%	188	2	47	57	126	J	165	J	68 3	J	136	J	146	J	80 6	J
Thallium	MG/KG	1 2	17%	0 855	3	9	54					0 19	U	1.5	U	0.23	U	0 43	J
Vanadium	MG/KG	32 7	100%	150	0	57	57	17 2		17 6		31 8		13 3		17		32 7	
Zinc	MG/KG	126	95%	115	2	54	57	42 4		[illegible]		83 2		0		0		81 9	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								SB13-1		SB13-1		MW13-6		MW13-6		MW13-6		SB17-1	
QC CODE								SA		SA		SA		SA		SA		SA	
STUDY ID								ESI		ESI		ESI		ESI		ESI		ESI	
TOP										6		0		4		6		0	
BOTTOM										8		2		6		8		2	
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE			FREQUENCY		NUMBER	NUMBER	NUMBER			12/8/1993		15-Dec-93		15-Dec-93		15-Dec-93		12/1/1993	
SAMP ID			OF		ABOVE	OF	OF	SB13-1-2		SB13-1-3		SB13-6-1		SB13-6-3		SB13-6-4		SB17-1-1	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	8250		11700		16000		13500		10200		13700	
Antimony	MG/KG	6 8	18%	6	2	10	57	3 7	UJ	2 8	UJ	3.2	UJ	2.5	UJ	2.9	UJ	11 7	UJ
Arsenic	MG/KG	21 5	95%	8 9	2	54	57	6 2		5 7		4 6		2 7		2.3		4 3	
Barium	MG/KG	159	100%	300	0	57	57	88 1		33 9		103		60 4		56 8		107	
Beryllium	MG/KG	1 4	100%	1 13	2	57	57	0 42	J	0 54	J	0.92		0 71		0 58	J	0 7	J
Cadmium	MG/KG	2 9	35%	2.46	2	20	57	0 36	U	0 27	U	0 31	U	0 25	U	0.28	U	0 73	U
Calcium	MG/KG	293000	100%	125300	2	57	57	87700		50300		5140		31800		45200		2870	
Chromium	MG/KG	32 7	100%	30	2	57	57	13 3		19 6		21 5		23 5		17 8		17 6	
Cobalt	MG/KG	29.1	100%	30	0	57	57	7 2	J	11.1		10.6		15		11.3		9.9	J
Copper	MG/KG	62 8	100%	33	3	57	57	18 4		17 6		16		27 4		14 5		[illegible]	
Cyanide	MG/KG	0	0%	0 35	0	0	51	0 5	U	0 53	U	0 6	U	0 53	U	0 51	U	0	NA
Iron	MG/KG	38600	100%	37410	2	57	57	17400		24700		25300		26900		20700		25100	
Lead	MG/KG	266	95%	24 4	3	54	57	0		0		13 8		11.6		11 7		[illegible]	
Magnesium	MG/KG	29100	100%	21700	2	54	54	20800		12600		3750		6640		5220		3330	
Manganese	MG/KG	2380	95%	1100	2	54	57	517		404		934		508		556		547	
Mercury	MG/KG	0 13	72%	0 1	2	41	57	0 07	J	0 02	U	0 03	J	0 01	U	0.01	U	0 05	J
Nickel	MG/KG	62 3	98%	50	2	56	57	24		33.1		22.7		41.9		33		19 1	
Potassium	MG/KG	3160	100%	2623	2	57	57	1390		1270		1330		1120		1000		628	J
Selenium	MG/KG	1 7	40%	2	0	23	57	0 56	J	0 51	J	1 2		0.11	J	0 24	J	0.25	UJ
Silver	MG/KG	0 87	4%	0 8	1	2	54	0 71	U	0 54	U	0 62	U	0 49	U	0 56	U	1.5	U
Sodium	MG/KG	269	82%	188	2	47	57	155	J	134	J	61 9	J	116	J	141	J	46 2	J
Thallium	MG/KG	1 2	17%	0 855	3	9	54	0 43	J	0 64	J	0 18	U	0 14	U	0.23	U	0 28	UJ
Vanadium	MG/KG	32 7	100%	150	0	57	57	13 3		16 3		29 9		18 5		13 8		23 1	
Zinc	MG/KG	126	95%	115	2	54	57	56 2		45.8		82 5		64.7		39 3		93 4	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								SB17-1		SB17-1		SB26-1		SB26-1		SB4-1		SB4-1	
QC CODE								SA		SA		SA		SA		SA		DU	
STUDY ID								ESI		ESI		ESI		ESI		ESI		ESI	
TOP								2		4		0		2		0		0	
BOTTOM								4		6		2		4		2		2	
MATRIX								SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
SAMPLE DATE			FREQUENCY		NUMBER	NUMBER	NUMBER	12/1/1993		12/1/1993		11/17/1993		11/17/1993		12/6/1993		12/6/1993	
SAMP ID			OF		ABOVE	OF	OF	SB17-1-2		SB17-1-3		SB26-1-1		SB26-1-2		SB4-1-1		SB4-1-10	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	MG/KG	21000	100%	19520	3	57	57	18100		8700		5560		9040		14800		[illegible]	
Antimony	MG/KG	6 8	18%	6	2	10	57	11.8	UJ	9	UJ	7.3	UJ	6 7	UJ	4.8	UJ	3.8	UJ
Arsenic	MG/KG	21.5	95%	8 9	2	54	57	5 2		3 4		3 2		5 3		8 2		4 2	
Barium	MG/KG	159	100%	300	0	57	57	114		59 4		73.2		43 7		72		87.7	
Beryllium	MG/KG	1.4	100%	1 13	2	57	57	0 9	J	0 42	J	0.35	J	0 41	J	0.73	J	0.64	J
Cadmium	MG/KG	2 9	35%	2.46	2	20	57	0 74	U	0 56	U	0 46	U	0 42	U	0 47	U	0.37	U
Calcium	MG/KG	293000	100%	125300	2	57	57	20900		72800		[illegible]		47300		4280		2460	
Chromium	MG/KG	32.7	100%	30	2	57	57	25.1		13 9		10.3		15 7		23.2		27.9	
Cobalt	MG/KG	29 1	100%	30	0	57	57	13 3		8 8		5 9	J	9.5		11.3		5 9	J
Copper	MG/KG	62 8	100%	33	3	57	57	26 9		20		9.7		14 3		14 1		15 1	
Cyanide	MG/KG	0	0%	0 35	0	0	51	0	NA	0	NA	0 48	U	0 57	U	0 52	U	0 53	U
Iron	MG/KG	38600	100%	37410	2	57	57	29900		18800		8770		19100		27500		19500	
Lead	MG/KG	266	95%	24 4	3	54	57	11 4	J	7 5	J	6 33		8 5		0	J	9 8	J
Magnesium	MG/KG	29100	100%	21700	2	54	54	8490		18100		[illegible]		9160		4270		4460	
Manganese	MG/KG	2380	95%	1100	2	54	57	487		391		309		551		815	J	0	J
Mercury	MG/KG	0 13	72%	0 1	2	41	57	0 06	J	0 03	UJ	0 02	U	0 02	U	0 05	J	0 04	J
Nickel	MG/KG	62 3	98%	50	2	56	57	42		25 2		31 6	R	23 9		27 8		25 1	
Potassium	MG/KG	3160	100%	2623	2	57	57	1560		1090		1710		901		1250		2490	
Selenium	MG/KG	1 7	40%	2	0	23	57	0 24	UJ	0 14	UJ	0 13	UJ	0 26	J	0 4	J	0 23	J
Silver	MG/KG	0 87	4%	0 8	1	2	54	1 5	U	1 1	U	0 92	UJ	0 85	UJ	0 93	U	0 74	U
Sodium	MG/KG	269	82%	188	2	47	57	74 6	J	137	J	[illegible]	J	108	J	43 8	U	39 2	J
Thallium	MG/KG	1 2	17%	0.855	3	9	54	0 26	UJ	0 15	UJ	0 73	U	0 17	U	0 23	U	0 23	U
Vanadium	MG/KG	32 7	100%	150	0	57	57	27		13 9		12 7		14 4		28 6		31	
Zinc	MG/KG	126	95%	115	2	54	57	80 2		57 1		283	R	90 6		79 6		72 1	

TABLE D-5
BACKGROUND SOIL DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

LOC_ID								SB4-1		SB4-1		TP57-11	
QC CODE								SA		SA		SA	
STUDY ID								ESI		ESI		ESI	
TOP								4		8		3	
BOTTOM								6		10		3	
MATRIX								SOIL		SOIL		SOIL	
SAMPLE DATE			FREQUENCY		NUMBER	NUMBER	NUMBER	12/6/1993		12/6/1993		11/8/1993	
SAMP ID			OF		ABOVE	OF	OF	SB4-1-2		SB4-1-3		TP57-11	
COMPOUND	UNIT	MAXIMUM	DETECTION	TAGM	TAGM	DETECTS	ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q
METALS													
Aluminum	MG/KG	21000	100%	19520	3	57	57	15300		19200		14600	
Antimony	MG/KG	6 8	18%	6	2	10	57	5	UJ	2.8	UJ	11.3	UJ
Arsenic	MG/KG	21.5	95%	8.9	2	54	57	3 9		[illegible]		5 9	
Barium	MG/KG	159	100%	300	0	57	57	40 4	J	81.2		120	
Beryllium	MG/KG	1.4	100%	1.13	2	57	57	0 74	J	1		0 81	J
Cadmium	MG/KG	2 9	35%	2 46	2	20	57	0 49	U	0.27	U	0.71	U
Calcium	MG/KG	293000	100%	125300	2	57	57	30900		14400		22300	
Chromium	MG/KG	32 7	100%	30	2	57	57	27 6		[illegible]		20 1	
Cobalt	MG/KG	29.1	100%	30	0	57	57	16 5		29 1		8 8	J
Copper	MG/KG	62 8	100%	33	3	57	57	[illegible]		21 6		21 7	
Cyanide	MG/KG	0	0%	0 35	0	0	51	0 53	U	0 47	U	0 54	U
Iron	MG/KG	38600	100%	37410	2	57	57	34300		[illegible]		24900	
Lead	MG/KG	266	95%	24.4	3	54	57	7 5	J	9 1	J	11 3	
Magnesium	MG/KG	29100	100%	21700	2	54	54	7130		8040		5360	
Manganese	MG/KG	2380	95%	1100	2	54	57	0		0		329	
Mercury	MG/KG	0 13	72%	0 1	2	41	57	0 04	J	0.04	J	0 04	J
Nickel	MG/KG	62.3	98%	50	2	56	57	47 6		[illegible]		25 7	
Potassium	MG/KG	3160	100%	2623	2	57	57	1300		2030		1430	
Selenium	MG/KG	1 7	40%	2	0	23	57	0 09	U	0 14	U	0 46	J
Silver	MG/KG	0 87	4%	0 8	1	2	54	0 98	U	0 64	J	1 4	UJ
Sodium	MG/KG	269	82%	188	2	47	57	105	J	91 6	J	93	J
Thallium	MG/KG	1.2	17%	0 855	3	9	54	0 16	U	0 24	U	0 17	U
Vanadium	MG/KG	32 7	100%	150	0	57	57	22 2		29 3		27 8	
Zinc	MG/KG	126	95%	115	2	54	57	102		115		57 9	

TABLE D-6
BACKGROUND GROUND WATER DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

STUDY ID								3Q93		RI PHASE		ESI		ESI		ESI		RI ROUND	
LOC ID								MW-35		MW-35		MW11-1		MW13-1		MW13-6		MW16-1	
QC CODE								SA		SA		SA		SA		SA		SA	
SAMP DETH TOP								NONE		NONE		NONE		NONE		NONE		3 3	
SAMP DEPTH BOT								NONE		NONE		NONE		NONE		NONE		5 3	
MATRIX								GROUND		GROUND		GROUND		GROUND		GROUND		GROUND	
SAMP ID								MW35OB3		MW-35GW		MW11-1-1		MW13-1-1		MW13-6-1		16101	
PARAMETER	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NY AWQS CLASS GA	NUMBER ABOVE CRITERIA	NUMBER OF DETECTS	NUMBER OF ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Alumınum	UG/L	42400	87%		0	27	31	207		7550	J	53 7	J	42400		2810		1850	
Antimony	UG/L	52 7	13%		0	4	31	16 8	U	55 5	U	21 4	U	33 9	J	52 7	J	2	U
Arsenic	UG/L	10	13%	25	0	4	31	1	B	3 5	U	0 8	U	9 3	J	1.4	U	2 7	U
Barium	UG/L	337	94%	1000	0	29	31	97 3	C	103	J	25.2	J	337		34.3	J	74 2	
Beryllium	UG/L	2 2	13%		0	4	31	0 3	U	1.8	R	0 4	U	2 2	J	0.4	U	0 23	
Cadmium	UG/L	0	0%	10	0	0	31	2 4	U	2 9	U	2 1	U	2 1	U	2.1	U	0.3	U
Calcium	UG/L	181000	100%		0	31	31	108000		94700		97500		181000		81500		157000	
Chromium	UG/L	69 4	48%	50	1	15	31	3 3	U	15 3	R	2 6	U	[illegible]		6.1	J	2.7	
Cobalt	UG/L	34 6	45%		0	14	31	2 7	U	19 9	J	4.4	U	34 6	J	4.4	U	2.1	
Copper	UG/L	32 5	48%	200	0	15	31	2 1	U	14 4	U	3.1	U	23.3	J	3 1	U	4 9	
Cyanide	UG/L	2 8	3%	100	0	1	31	2 8	B	10	UJ	5	U	5	U	5	U	5	U
Iron	UG/L	69400	100%	300	22	31	31	[illegible]		[illegible]		41.4	J	69400		[illegible]		[illegible]	J
Lead	UG/L	34.8	32%	25	1	10	31	2.8	B	3 3		1.1	J	[illegible]		1.5	J	1 7	U
Magnesium	UG/L	58200	100%		0	31	31	15600		14600		29700		50300		51500		23300	
Manganese	UG/L	1120	97%	300	8	30	31	23 4		[illegible]	J	278		[illegible]		[illegible]		210	
Mercury	UG/L	0 06	23%	0 7	0	7	31	0 1	U	0.18	R	0.04	U	0.05	J	0.04	U	0.1	U
Nickel	UG/L	99.8	61%	100	0	19	31	8 3	U	15 9	U	4	U	99 8		8.6	J	4 7	
Potassium	UG/L	10200	94%		0	29	31	1400	B	4180	J	7100		10100		6780	J	1670	
Selenium	UG/L	3 6	19%	10	0	6	31	1 2	B	1 1	J	0 7	U	3.6	J	2 3	J	2 4	U
Silver	UG/L	0.98	6%	50	0	2	31	2 6	U	9	U	4 2	U	4 2	U	4 2	U	1 3	U
Sodium	UG/L	59400	97%	20000	7	30	31	13400		44100		4660	J	9350		7880		8750	
Thallium	UG/L	4.7	13%		0	4	31	1 2	U	3 2	U	1 2	U	1 2	U	1 2	U	4 2	U
Vanadium	UG/L	70.8	52%		0	16	31	3	U	30 3	U	3 7	U	70 8		5.9	J	3 3	
Zinc	UG/L	143	84%	300	0	26	31	72 7		58.2		21.4		143		50.8		15 6	R

TABLE D-6
BACKGROUND GROUND WATER DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

STUDY ID								RI ROUND		RI ROUND		RI ROUND		RI ROUND		RI ROUND		ESI	
LOC ID								MW16-1		MW17-1		MW17-1		MW25-6		MW25-6		MW26-1	
QC CODE								SA		SA		SA		SA		SA		SA	
SAMP DETH TOP								731 5		3 4		731 1		NONE		NONE		NONE	
SAMP DEPTH BOT								728 4		7 4		727 1		NONE		NONE		NONE	
MATRIX								GROUND		GROUND		GROUND		GROUND		GROUND		GROUND	
SAMP ID:								16152		16108		16171		MW25-6		25008		MW26-1-1	
PARAMETER	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NY AWQS CLASS GA	NUMBER ABOVE CRITERIA	NUMBER OF DETECTS	NUMBER OF ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	UG/L	42400	87%		0	27	31	143	U	90 4		386		162		529		188	J
Antimony	UG/L	52 7	13%		0	4	31	3	U	2	U	3	U	2.2	U	2.3	U	21.5	U
Arsenic	UG/L	10	13%	25	0	4	31	4 4	U	2 7	U	4 4	U	2 1	U	3.5	U	0 8	U
Barium	UG/L	337	94%	1000	0	29	31	48 2	U	85		90 4	U	85 6		72.3		31 9	J
Beryllium	UG/L	2 2	13%		0	4	31	0 2	U	0 26		0 2	U	0 27	U	0 13	U	0 4	U
Cadmium	UG/L	0	0%	10	0	0	31	0 6	U	0.3	U	0 6	U	0.3	U	0.32	U	2 1	U
Calcium	UG/L	181000	100%		0	31	31	116000		108000		104000		133000		118000		115000	
Chromium	UG/L	69 4	48%	50	1	15	31	1	U	1	U	1	U	2.2		1.3	U	2.6	U
Cobalt	UG/L	34 6	45%		0	14	31	1 3	U	1 2	U	2	U	1.3		1.1	U	4.4	U
Copper	UG/L	32 5	48%	200	0	15	31	1 9	U	3 1		1.1	U	0.99		1.1		3.1	U
Cyanide	UG/L	2.8	3%	100	0	1	31	5	UJ	5	U	5	UJ	5	U	5	UJ	5	U
Iron	UG/L	69400	100%	300	22	31	31	298		119		[redacted]	J	[redacted]		[redacted]		286	
Lead	UG/L	34 8	32%	25	1	10	31	1 5	U	1 7	U	1.5	U	4.4		1.1	U	0 5	U
Magnesium	UG/L	58200	100%		0	31	31	17600		22600		22900		35900		32900		16700	
Manganese	UG/L	1120	97%	300	8	30	31	64 2		21 3		9 7	U	56		22		[redacted]	
Mercury	UG/L	0 06	23%	0 7	0	7	31	0 1	U	0.1	U	0 1	U	0 02	U	0 1	U	0.05	J
Nickel	UG/L	99.8	61%	100	0	19	31	2 5	U	1 8		2 5	U	2 6		1.7	U	4	U
Potassium	UG/L	10200	94%		0	29	31	998	U	472		843	U	1840	J	1420		10200	
Selenium	UG/L	3 6	19%	10	0	6	31	4 7	UJ	2 4	U	4 7	UJ	3 7	U	3.4	U	0 7	U
Silver	UG/L	0 98	6%	50	0	2	31	1 5	U	1 3	U	1 5	U	0 8	U	1 1	U	4.2	U
Sodium	UG/L	59400	97%	20000	7	30	31	3870	U	9290		8190		[redacted]	J	16500		[redacted]	
Thallium	UG/L	4 7	13%		0	4	31	5 9	U	4 4		4 1	U	3	U	3.5	U	1 2	U
Vanadium	UG/L	70 8	52%		0	16	31	1 6	U	1 2	U	1 6	U	1.4		1 2	U	3 7	U
Zinc	UG/L	143	64%	300	0	26	31	5 8	U	2 5	R	14 4	U	7.5		2.2		26 7	

TABLE D-6
BACKGROUND GROUND WATER DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

STUDY ID								RI ROUND		RI ROUND		ESI		ESI		ESI		ESI	
LOC ID								MW26-1		MW26-1		MW4-1		MW44A-1		MW44B-1		MW57-1	
QC CODE								SA		SA		SA		SA		SA		SA	
SAMP DETH TOP								NONE		NONE		NONE		NONE		NONE		NONE	
SAMP DEPTH BOT								NONE		NONE		NONE		NONE		NONE		NONE	
MATRIX								GROUND		GROUND		GROUND		GROUND		GROUND		GROUND	
SAMP ID								MW26-1		26001		MW4-1-1		MW44A-1-		MW44B-1-		MW57-1-1	
PARAMETER	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NY AWQS CLASS GA	NUMBER ABOVE CRITERIA	NUMBER OF DETECTS	NUMBER OF ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	UG/L	42400	87%		0	27	31	457		38.7		41 9	U	69	J	288	J	4200	
Antimony	UG/L	52.7	13%		0	4	31	2 2	U	1 4		21 6	U	1 3	U	1.3	U	44 7	J
Arsenic	UG/L	10	13%	25	0	4	31	2 1	U	4	U	2 2	J	2	U	2	U	1 4	U
Barium	UG/L	337	94%	1000	0	29	31	33 2		29 9		19 6	J	102	J	72.6	J	36.5	J
Beryllium	UG/L	2 2	13%		0	4	31	0 27	U	0 1	U	0.4	U	0 1	U	0.1	U	0.4	U
Cadmium	UG/L	0	0%	10	0	0	31	0 3	U	0 3	U	2 1	U	0 2	U	0.2	U	2 1	U
Calcium	UG/L	181000	100%		0	31	31	121000		110000		137000		92200		120000		82000	
Chromium	UG/L	69 4	48%	50	1	15	31	4.7		0 73		2 6	U	0 4	U	0.4	U	7 7	J
Cobalt	UG/L	34 8	45%		0	14	31	1.1		0 9	U	4 6	J	0.5	U	0 91	J	4 4	U
Copper	UG/L	32 5	48%	200	0	15	31	5 7		1	U	3 1	U	0.5	U	0.5	U	3.1	U
Cyanide	UG/L	2.8	3%	100	0	1	31	5	U	5	U	5	U	5	U	5	U	5	U
Iron	UG/L	69400	100%	300	22	31	31	[illegible]		58.4	J	[illegible]		114	J	[illegible]		[illegible]	
Lead	UG/L	34 8	32%	25	1	10	31	7 8		1 9	U	0 5	U	0.9	U	0.9	U	2 1	J
Magnesium	UG/L	58200	100%		0	31	31	16600		15500		57600		19000		31800		11400	
Manganese	UG/L	1120	97%	300	8	30	31	27 5		2 5		[illegible]		18 2		219		245	
Mercury	UG/L	0.06	23%	0 7	0	7	31	0 02	U	0 2	U	0 04	U	0.04	U	0.04	U	0 04	U
Nickel	UG/L	99.8	61%	100	0	19	31	6 2		1 6	U	4	U	0.7	U	0.73	J	8 2	J
Potassium	UG/L	10200	94%		0	29	31	3620		3860	J	7380		1050	J	2150	J	3860	J
Selenium	UG/L	3 6	19%	10	0	6	31	3 7	U	3 4	U	2 1	J	2 7	U	2 7	U	0 69	U
Silver	UG/L	0 98	6%	50	0	2	31	0.8	U	1 3	U	4 2	U	0 5	U	0 68	J	4 2	U
Sodium	UG/L	59400	97%	20000	7	30	31	[illegible]		[illegible]		11700		2310	J	7190		4080	J
Thallium	UG/L	4 7	13%		0	4	31	4 3		4 7	U	1 2	U	1 9	U	4.7	J	1 2	U
Vanadium	UG/L	70 8	52%		0	16	31	1 3	J	1.1	U	3 7	U	0 5	U	0 5	U	7 6	J
Zinc	UG/L	143	84%	300	0	26	31	20 5		3 1	J	19 1	J	3.8	J	2 2	U	57 4	

TABLE D-6
BACKGROUND GROUND WATER DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

STUDY ID								ESI		ESI		ESI		ESI		ESI		RI PHASE	
LOC ID								MW58-1		MW64A-1		MW64B-1		MW64C-9		MW64D-1		PT-10	
OC CODE								SA		SA		SA		SA		SA		SA	
SAMP DETH TOP								NONE		NONE		NONE		NONE		NONE		NONE	
SAMP DEPTH BOT								NONE		NONE		NONE		NONE		NONE		NONE	
MATRIX								GROUND		GROUND		GROUND		GROUND		GROUND		GROUND	
SAMP ID								MW58-1-1		MW64A-1-		MW64B-1-		MW64C-9-		MW64D-1-		PT10GW1	
PARAMETER	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NY AWQS CLASS GA	NUMBER ABOVE CRITERIA	NUMBER OF DETECTS	NUMBER OF ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	UG/L	42400	87%		0	27	31	440		398		198	J	38 2	J	177	J	72	U
Antimony	UG/L	52 7	13%		0	4	31	1 3	U	1 3	U	1.3	U	1 3	U	1 3	U	49 5	UJ
Arsenic	UG/L	10	13%	25	0	4	31	2	U	2	U	2	U	2	U	2	U	1 4	UJ
Barium	UG/L	337	94%	1000	0	29	31	71 9	J	42	J	104	J	20 4	J	88.6	J	193	J
Beryllium	UG/L	2 2	13%		0	4	31	0 1	U	0 1	U	0 1	U	0.1	U	0.1	U	0.89	U
Cadmium	UG/L	0	0%	10	0	0	31	0 2	U	0 2	U	0 2	U	0.2	U	0 2	U	2 8	U
Calcium	UG/L	181000	100%		0	31	31	113000		109000		138000		121000		142000		79100	
Chromium	UG/L	69 4	48%	50	1	15	31	0 82	J	0 49	J	0 41	J	0.4	U	0.4	U	2 7	UJ
Cobalt	UG/L	34 6	45%		0	14	31	0 64	J	0 5	U	1 1	J	0 5	U	0.69	J	5 4	U
Copper	UG/L	32.5	48%	200	0	15	31	1.5	J	0 61	J	1	J	0.55	J	0.5	U	4 7	U
Cyanide	UG/L	2 8	3%	100	0	1	31	5	U	5	U	5	U	5	U	5	U	10	UJ
Iron	UG/L	69400	100%	300	22	31	31	[illegible]		[illegible]	J	[illegible]		[illegible]		[illegible]		85 6	J
Lead	UG/L	34 8	32%	25	1	10	31	0 89	U	0.89	U	0 9	U	0 9	U	0.9	U	0 79	U
Magnesium	UG/L	58200	100%		0	31	31	17300		16800		45600		49400		14800		34200	
Manganese	UG/L	1120	97%	300	8	30	31	84		28 3		98 9		96		223		124	
Mercury	UG/L	0 08	23%	0 7	0	7	31	0 04	U	0 04	J	0 04	U	0 04	U	0 04	U	0 09	UJ
Nickel	UG/L	99.8	61%	100	0	19	31	1 6	J	1	J	1 4	J	1 2	J	1.4	J	7 4	UJ
Potassium	UG/L	10200	94%		0	29	31	1460	J	1790	J	4780	J	1670	J	3340	J	2870	J
Selenium	UG/L	3.6	19%	10	0	6	31	2 7	U	2 7	U	2.7	U	2.7	U	2.7	U	0 99	UJ
Silver	UG/L	0.98	6%	50	0	2	31	0 5	U	0 5	U	0 5	U	0 5	U	0 5	U	5 4	U
Sodium	UG/L	59400	97%	20000	7	30	31	4180	J	2180	J	8140		6420		12300		[illegible]	
Thallium	UG/L	4 7	13%		0	4	31	1 9	U	1 9	U	1 9	U	1.9	U	2 2	J		
Vanadium	UG/L	70 8	52%		0	16	31	0 81	J	1 3	J	0 73	J	0 61	J	0 69	J	6 7	UJ
Zinc	UG/L	143	84%	300	0	26	31	7 1	J	3 9	J	3 9	J	3.9	J	3.8	J	8 8	J

TABLE D-6
BACKGROUND GROUND WATER DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

STUDY ID								ESI		QUARTER		ESI		ESI		ESI		ESI	
LOC ID								MW24-1		MW45-4		MW60-1		MW62-1		MW63-1		MW67-1	
QC CODE								SA		SA		SA		SA		SA		SA	
SAMP DETH TOP								NONE		NONE		NONE		NONE		NONE		NONE	
SAMP DEPTH BOT								NONE		NONE		NONE		NONE		NONE		NONE	
MATRIX								GROUND		GROUND		GROUND		GROUND		GROUND		GROUND	
SAMP ID								MW24-1		OB108		MW60-1		MW62-1		MW63-1		MW67-2	
PARAMETER	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NY AWQS CLASS GA	NUMBER ABOVE CRITERIA	NUMBER OF DETECTS	NUMBER OF ANALYSES	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
METALS																			
Aluminum	UG/L	42400	87%		0	27	31	19100		36 8	U	348		499		747		1240	
Antimony	UG/L	52 7	13%		0	4	31	21 5	U	2 8	U	1 3	U	1.3	U	1.3	U	1 3	U
Arsenic	UG/L	10	13%	25	0	4	31	10		3 6	U	2	U	2	U	2	U	2	U
Barium	UG/L	337	94%	1000	0	29	31	156	J	23 4		88 7	J	68 1	J	72 6	J	100	J
Beryllium	UG/L	2 2	13%		0	4	31	0 89	J	0 1	U	0 1	U	0.1	U	0.1	U	0 1	U
Cadmium	UG/L	0	0%	10	0	0	31	2 1	U	0 4	U	0 2	U	0 2	U	0.2	U	0 2	U
Calcium	UG/L	161000	100%		0	31	31	180000		112000		95100		91700		89400		119000	
Chromium	UG/L	69 4	48%	50	1	15	31	29 8		1 3	U	0 56	J	1 4	J	1 1	J	2	J
Cobalt	UG/L	34 6	45%		0	14	31	18 7	J	1 4	U	0 5	U	2.5	J	6.2	J	1 4	J
Copper	UG/L	32.5	48%	200	0	15	31	32 5		1 5		0 5	U	0.54	J	2.1	J	1 5	J
Cyanide	UG/L	2 8	3%	100	0	1	31	5	U			5	U	5	UJ	5	U	5	U
Iron	UG/L	69400	100%	300	22	31	31	[illegible]		62 8		[illegible]		[illegible]	J	[illegible]		[illegible]	
Lead	UG/L	34.8	32%	25	1	10	31	7		2	U	0 9	U	0.89	U	1.1	J	0 9	U
Magnesium	UG/L	58200	100%		0	31	31	39800		24200		31100		58200		16400		24200	
Manganese	UG/L	1120	97%	300	8	30	31	[illegible]		5	J	[illegible]		271		[illegible]		153	
Mercury	UG/L	0 08	23%	0 7	0	7	31	0 08	J	0 2	U	0 05	J	0 05	J	0 04	U	0 04	U
Nickel	UG/L	99 8	61%	100	0	19	31	41 4		2 2		0 7	U	3 9	J	9.7	J	2.9	J
Potassium	UG/L	10200	94%		0	29	31	9220		2180		8760		7470	J	3870	J	1870	J
Selenium	UG/L	3 6	19%	10	0	6	31	2 5	J	3 1	U	2 7	U	2 7	U	2.7	U	2 7	U
Silver	UG/L	0 98	6%	50	0	2	31	4 2	U	0.98		0 5	U	0 5	U	0 5	U	0 5	U
Sodium	UG/L	59400	97%	20000	7	30	31	5950		10600		[illegible]		18100		5710		13700	
Thallium	UG/L	4 7	13%		0	4	31	1 2	U	4	U	1.9	U	1 9	U	1 9	U	1 9	U
Vanadium	UG/L	70 8	52%		0	16	31	30 9	J	1 2	U	1	J	1 8	J	1.5	J	2 1	J
Zinc	UG/L	143	84%	300	0	26	31	107		6 8		6 9	J	4 2	J	7.1	J	6 5	J

TABLE D-6
BACKGROUND GROUND WATER DATA
SEAD-63 EE/CA
Seneca Army Depot Activity

STUDY ID								ESI	
LOC ID								MW70-1	
QC CODE								SA	
SAMP DETH TOP								NONE	
SAMP DEPTH BOT								NONE	
MATRIX								GROUND	
SAMP ID								MW70-1	
PARAMETER	UNIT	MAXIMUM	FREQUENCY OF DETECTION	NY AWQS CLASS GA	NUMBER ABOVE CRITERIA	NUMBER OF DETECTS	NUMBER OF ANALYSES	VALUE	Q
METALS									
Aluminum	UG/L	42400	87%		0	27	31	88 2	J
Antimony	UG/L	52 7	13%		0	4	31	1 3	U
Arsenic	UG/L	10	13%	25	0	4	31	2	U
Barium	UG/L	337	94%	1000	0	29	31	86 5	J
Beryllium	UG/L	2 2	13%		0	4	31	0 1	U
Cadmium	UG/L	0	0%	10	0	0	31	0 2	U
Calcium	UG/L	181000	100%		0	31	31	119000	
Chromium	UG/L	69 4	48%	50	1	15	31	0 4	U
Cobalt	UG/L	34 6	45%		0	14	31	0 5	U
Copper	UG/L	32 5	48%	200	0	15	31	0 5	U
Cyanide	UG/L	2 8	3%	100	0	1	31	5	U
Iron	UG/L	69400	100%	300	22	31	31	213	
Lead	UG/L	34 8	32%	25	1	10	31	0 9	U
Magnesium	UG/L	58200	100%		0	31	31	28100	
Manganese	UG/L	1120	97%	300	8	30	31	107	
Mercury	UG/L	0 06	23%	0 7	0	7	31	0 06	J
Nickel	UG/L	99 8	61%	100	0	19	31	1 5	J
Potassium	UG/L	10200	94%		0	29	31	1540	J
Selenium	UG/L	3 8	19%	10	0	6	31	2 7	U
Silver	UG/L	0 98	6%	50	0	2	31	0 5	U
Sodium	UG/L	59400	97%	20000	7	30	31	5220	
Thallium	UG/L	4 7	13%		0	4	31	1 9	U
Vanadium	UG/L	70 8	52%		0	16	31	0 5	U
Zinc	UG/L	143	84%	300	0	26	31	3 5	J

SURFACE WATER AND SEDIMENT DATA COLLECTED DURING PHASE I RI

TABLE D-7: SEDIMENT DATA
TABLE D-8: SURFACE WATER DATA

T 7
SED ATA
S 3

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67747		67747		67747		67747		67747		67747		67747	
	LOC ID:	SWSD63-14		SWSD63-14		SWSD63-10		SWSD63-15		SWSD63-8		SWSD63-5		SWSD63-13	
	SAMP_ID:	12217		63111		63112		63113		63114		63115		63116	
	FIELD QC CODE:	DU		SA		SA		SA		SA		SA		SA	
	SAMP. DEPTH TOP:	0.3		0.3		0.3		0.2		0.2		0.2		0.2	
	SAMP. DEPTH BOT:	0.5		0.5		0.5		0.4		0.4		0.4		0.4	
	MATRIX:	SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		13-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
VOLATILES															
1,1,1-Trichloroethane	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
1,1,2,2-Tetrachloroethane	UG/KG	17	UJ	18	UJ	14	U	16	U	15	U	15	U	14	U
1,1,2-Trichloroethane	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
1,1-Dichloroethane	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
1,1-Dichloroethene	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
1,2-Dichloroethane	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
1,2-Dichloroethene (total)	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
1,2-Dichloropropane	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Acetone	UG/KG	24	J	21	UJ	68	J	16	U	15	U	15	U	25	
Benzene	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Bromodichloromethane	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Bromoform	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Carbon disulfide	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Carbon tetrachloride	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Chlorobenzene	UG/KG	17	UJ	18	UJ	14	U	16	U	15	U	15	U	14	U
Chlorodibromomethane	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Chloroethane	UG/KG	17	U	18	U	14	U	16	U	16	U	15	U	14	U
Chloroform	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Cis-1,3-Dichloropropene	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Ethyl benzene	UG/KG	17	UJ	18	UJ	14	U	16	U	15	U	15	U	14	U
Methyl bromide	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Methyl butyl ketone	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Methyl chloride	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Methyl ethyl ketone	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Methyl isobutyl ketone	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Methylene chloride	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Styrene	UG/KG	17	UJ	18	UJ	14	U	16	U	15	U	15	U	14	U
Tetrachloroethene	UG/KG	17	UJ	18	UJ	14	U	16	U	15	U	15	U	14	U
Toluene	UG/KG	17	UJ	18	UJ	14	U	16	U	15	U	15	U	14	U
Total Xylenes	UG/KG	17	UJ	18	UJ	14	U	16	U	15	U	15	U	14	U
Trans-1,3-Dichloropropene	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Trichloroethene	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
Vinyl chloride	UG/KG	17	U	18	U	14	U	16	U	15	U	15	U	14	U
SEMI-VOLATILES															
1,2-Dichlorobenzene	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
1,3-Dichlorobenzene	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
1,4-Dichlorobenzene	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2,4,5-Trichlorophenol	UG/KG	280	U	290	U	400	U	300	U	230	U	280	U	220	U
2,4,6-Trichlorophenol	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2,4-Dichlorophenol	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2,4-Dimethylphenol	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2,4-Dinitrophenol	UG/KG	280	U	290	U	400	U	300	U	230	U	280	U	220	U
2,4-Dinitrotoluene	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2,6-Dinitrotoluene	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2-Chloronaphthalene	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2-Chlorophenol	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2-Methylnaphthalene	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2-Methylphenol	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
2-Nitroaniline	UG/KG	280	U	290	U	400	U	300	U	230	U	280	U	220	U
2-Nitrophenol	UG/KG	120	UJ	120	UJ	160	UJ	120	UJ	94	UJ	120	UJ	93	U
3,3'-Dichlorobenzidine	UG/KG	120	U	120	U	160	UJ	120	U	94	U	120	U	93	U
3-Nitroaniline	UG/KG	280	UJ	290	UJ	400	UJ	300	UJ	230	UJ	280	UJ	220	U
4,6-Dinitro-2-methylphenol	UG/KG	280	U	290	U	400	U	300	U	230	U	280	U	220	U
4-Bromophenyl phenyl ether	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
4-Chloro-3-methylphenol	UG/KG	120	U	120	U	160	U	120	U	94	U	120	U	93	U
4-Chloroaniline	UG/KG	120	UJ	120	UJ	160	UJ	120	UJ	94	UJ	120	UJ	93	U

TABLE D-7
SEDIMENT DATA
SEAD-63

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67747		67747		67747		67747		67747		67747		67747	
	LOC ID:	SWSD63-14		SWSD63-14		SWSD63-10		SWSD63-15		SWSD63-8		SWSD63-5		SWSD63-13	
	SAMP_ID:	12217		63111		63112		63113		63114		63115		63116	
	FIELD QC CODE:	DU		SA		SA		SA		SA		SA		SA	
	SAMP. DEPTH TOP:	0.3		0 3		0.3		0 2		0 2		0.2		0 2	
	SAMP. DEPTH BOT:	0.5		0 5		0.5		0.4		0.4		0.4		0.4	
	MATRIX:	SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		13-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
4-Chlorophenyl phenyl ether	UG/KG	120.	U	120	U	160.	U	120	U	94.	U	120	U	93.	U
4-Methylphenol	UG/KG	120.	U	120	U	160.	U	120	U	94.	U	120.	U	93.	U
Acenaphthene	UG/KG	120	U	120	U	160	U	120	U	94	U	120.	U	93	U
Acenaphthylene	UG/KG	120.	U	120	U	160	U	120	U	94.	U	120.	U	93.	U
Anthracene	UG/KG	13.	J	11	J	160.	U	7.4	J	94.	U	120.	U	93.	U
Benzo(a)anthracene	UG/KG	120.		110	J	26.	J	75.	J	9.2	J	33.	J	93.	U
Benzo(a)pyrene	UG/KG	140.		130		56.	J	74.	J	12.	J	30.	J	93.	U
Benzo(b)fluoranthene	UG/KG	170.		160		72.	J	130.		18.	J	51.	J	93.	U
Benzo(ghi)perylene	UG/KG	100.	J	110	J	54.	J	74.	J	11.	J	37.	J	93.	U
Benzo(k)fluoranthene	UG/KG	120.		120		160.	U	63.	J	8.7	J	33.	J	93.	U
Bis(2-Chloroethoxy)methane	UG/KG	120.	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
Bis(2-Chloroethyl)ether	UG/KG	120	U	120	U	160.	U	120	U	94.	U	120.	U	93.	U
Bis(2-Chloroisopropyl)ether	UG/KG	120.	U	120	U	160.	U	120.	U	94.	U	120.	U	93.	U
Bis(2-Ethylhexyl)phthalate	UG/KG	120.	U	120	U	160.	U	120.	U	94.	U	120.	U	93.	U
Butylbenzylphthalate	UG/KG	15.	J	120	U	160.	U	120	U	94.	U	6.7	J	93.	U
Carbazole	UG/KG	24	J	19	J	160.	U	17.	J	94.	U	15.	J	93	U
Chrysene	UG/KG	150.		150		49.	J	100	J	13.	J	43.	J	93.	U
Di-n-butylphthalate	UG/KG	120	U	120	U	8.6	J	8.4	J	94.	U	8.5	J	12.	J
Di-n-octylphthalate	UG/KG	120.	U	120	U	160	U	120.	U	94.	U	120.	U	93.	U
Dibenz(a,h)anthracene	UG/KG	34.	J	28	J	160.	U	12.	J	94.	U	8.8	J	93.	U
Dibenzofuran	UG/KG	120.	U	120.	U	160.	U	120	U	94.	U	120.	U	93.	U
Diethyl phthalate	UG/KG	6.2	J	8 2	J	92.	J	6.4	J	94	U	9.5	J	7.6	J
Dimethylphthalate	UG/KG	120.	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
Fluoranthene	UG/KG	250.		250.		43.	J	180.		25	J	82.	J	93.	U
Fluorene	UG/KG	5.3	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
Hexachlorobenzene	UG/KG	120.	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
Hexachlorobutadiene	UG/KG	120.	U	120	U	160.	U	120.	U	94.	U	120.	U	93.	U
Hexachlorocyclopentadiene	UG/KG	120.	UJ	120.	UJ	160.	UJ	120.	UJ	94.	UJ	120.	UJ	93.	UJ
Hexachloroethane	UG/KG	120.	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
Indeno(1,2,3-cd)pyrene	UG/KG	93.	J	97	J	27.	J	65.	J	9.5	J	28.	J	93	U
Isophorone	UG/KG	120.	U	120.	U	160.	U	120	U	94.	U	120.	U	93.	U
N-Nitrosodiphenylamine	UG/KG	120.	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
N-Nitrosodipropylamine	UG/KG	120.	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
Naphthalene	UG/KG	120.	U	120	U	160.	U	120.	U	94.	U	120.	U	93.	U
Nitrobenzene	UG/KG	120.	U	120.	U	160.	U	120.	U	94.	U	120.	U	93.	U
Pentachlorophenol	UG/KG	260.	U	290.	U	400.	U	300.	U	230.	U	280.	U	220.	U
Phenanthrene	UG/KG	68.	J	80.	J	37.	J	56.	J	11.	J	35.	J	6.4	J
Phenol	UG/KG	11.	J	120.	U	160.	U	120.	U	94.	U	120.	U	93	U
Pyrene	UG/KG	200.		160		45.	J	120.	J	17.	J	58.	J	93.	U
PESTICIDES/PCBs															
4,4'-DDD	UG/KG	5.9	U	6.	U	2.1	U	6 2	U	4.7	U	5.9	U	4.6	U
4,4'-DDE	UG/KG	5.9	U	6.	U	3.1	J	6 2	U	4.7	U	5.9	U	4.6	U
4,4'-DDT	UG/KG	5.9	U	6	U	8.3		6 2	U	4.7	U	5.9	U	4.6	U
Aldrin	UG/KG	3.	U	3 1	U	2 1	U	3.2	U	2.4	U	3.	U	2.4	U
Alpha-BHC	UG/KG	3.	U	3 1	U	2.1	U	3 2	U	2.4	U	3.	U	2.4	U
Alpha-Chlordane	UG/KG	3.	U	3.1	U	2.1	U	3.2	U	2.4	U	3.	U	2.4	U
Aroclor-1016	UG/KG	59.	U	60	U	41.	U	62.	U	47.	U	59.	U	46.	U
Aroclor-1221	UG/KG	120.	U	120	U	84.	U	130.	U	96.	U	120.	U	94.	U
Aroclor-1232	UG/KG	59	U	60	U	41.	U	62.	U	47.	U	59	U	46.	U
Aroclor-1242	UG/KG	59	U	60	U	41	U	62.	U	47.	U	59.	U	46.	U
Aroclor-1248	UG/KG	59.	U	60.	U	41.	U	62.	U	47.	U	59.	U	46.	U
Aroclor-1254	UG/KG	59	U	60	U	41.	U	62.	U	47.	U	59.	U	46.	U
Aroclor-1260	UG/KG	59.	U	60	U	41.	U	62.	U	47.	U	59.	U	46.	U
Beta-BHC	UG/KG	3	U	3.1	U	2.1	U	3 2	U	2.4	U	3.	U	2.4	U
Delta-BHC	UG/KG	3.	U	3.1	U	2.1	U	3 2	U	2.4	U	3.	U	2 4	U
Dieldrin	UG/KG	5.9	U	6.	U	4.1	U	6 2	U	4.7	U	5.9	U	4.6	U
Endosulfan I	UG/KG	3.	U	3.1	U	2.1	U	3.2	U	2.4	U	3.	U	2.4	U

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	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67747		67747		67747		67747		67747		67747		67747	
	LOC ID:	SWSD63-14		SWSD63-14		SWSD63-10		SWSD63-15		SWSD63-6		SWSD63-5		SWSD63-13	
	SAMP_ID:	12217		63111		63112		63113		63114		63115		63116	
	FIELD QC CODE:	DU		SA		SA		SA		SA		SA		SA	
	SAMP DEPTH TOP:	0.3		0.3		0.3		0.2		0.2		0.2		0.2	
	SAMP. DEPTH BOT:	0.5		0.5		0.5		0.4		0.4		0.4		0.4	
	MATRIX:	SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		13-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
Endosulfan II	UG/KG	5.9	U	6	U	4.1	U	6.2	U	4.7	U	5.9	U	4.6	U
Endosulfan sulfate	UG/KG	5.9	U	6.	U	4.1	U	6.2	U	4.7	U	5.9	U	4.6	U
Endrin aldehyde	UG/KG	5.9	U	6	U	4.1	U	6.2	U	4.7	U	5.9	U	4.6	U
Endrin ketone	UG/KG	5.9	U	6	U	4.1	U	6.2	U	4.7	U	5.9	U	4.6	U
Gamma-BHC/Lindane	UG/KG	3	U	3.1	U	2.1	U	3.2	U	2.4	U	3.	U	2.4	U
Gamma-Chlordane	UG/KG	3	U	3.1	U	2.1	U	3.2	U	2.4	U	3	U	2.4	U
Heptachlor	UG/KG	3	U	3.1	U	2.1	U	3.2	U	2.4	U	3.	U	2.4	U
Heptachlor epoxide	UG/KG	3.	U	3.1	U	2.1	U	3.2	U	2.4	U	3.	U	2.4	U
Methoxychlor	UG/KG	30.	U	31	U	21.	U	32	U	24.	U	30.	U	24	U
Toxaphene	UG/KG	300.	U	310	U	210.	U	320	U	240.	U	300	U	240.	U
METALS															
Aluminum	MG/KG	9,230.		7,030		2,600.		12,900.		9,090.		12,700.		15,200.	
Antimony	MG/KG	1.2	UJ	97	UJ	.7	UJ	1	UJ	98	UJ	.99	UJ	.75	UJ
Arsenic	MG/KG	3.2		3.1		2.5		5.		3.3		3.		5.6	
Barium	MG/KG	63.9		48.8		26.8		70.9		62.7		57.7		94.4	
Beryllium	MG/KG	3		25		08		49		.43		.48		.6	
Cadmium	MG/KG	.1	U	08	U	06	U	09	U	08	U	09	U	.06	U
Calcium	MG/KG	69,000		47,400		211,000		27,300		103,000.		3,750.		19,600	
Chromium	MG/KG	17.3		12.4		7.9		23.1		15.2		19.2		24.4	
Cobalt	MG/KG	11.2		8.2		2.7		12.8		6.9		7.		13.3	
Copper	MG/KG	30.5		22.1		7.4		33.4		18.7		18.2		30.8	
Cyanide	MG/KG	.89	UJ	.99	UJ	.63	UJ	1.	UJ	.72	UJ	1	UJ	.8	UJ
Iron	MG/KG	19,800.		12,700		6,360.		24,600.		17,200.		20,000.		29,700.	
Lead	MG/KG	35.4		24.9		3.4		34.7		17.2		18		15.7	
Magnesium	MG/KG	12,300.		7,590.		16,100		9,460		5,650.		3,820		7,140	
Manganese	MG/KG	746.	J	475.	J	315		559	J	255	J	217	J	520	J
Mercury	MG/KG	.07	U	09	U	.05	U	09	U	.07	U	.07	U	.06	U
Nickel	MG/KG	29		20.8		4.5		32.1		20.3		18.9		38.6	
Potassium	MG/KG	1,160.		1,160		509.		1,980		1,260		1,380.		1,840	
Selenium	MG/KG	1.7		1.3		94	U	2.1		1.2	U	1.4		1	U
Silver	MG/KG	.7	U	58	U	42	U	.61	U	54	U	8	U	.45	U
Sodium	MG/KG	202	U	343		122	U	266		170		172.	U	130.	U
Thallium	MG/KG	2.1	U	1.7	U	1.3	U	2.3		1.6	U	1.8	U	1.7	
Vanadium	MG/KG	20.9		15.8		11.7		24.3		17.3		20.9		24.	
Zinc	MG/KG	118.		87.4		24.7		432		66.6		60.4		72.1	

TABLE D-7
SEDIMENT DATA
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	STUDY ID	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67668		67668		67668		67668		67668		67668		67668	
	LOC ID	SWSD63-7		SWSD63-11		SWSD63-9		SWSD63-6		SWSD63-12		SWSD63-16		SWSD63-17	
	SAMP_ID.	63101		63102		63103		63104		63105		63106		63107	
	FIELD QC CODE:	SA		SA		SA		SA		SA		SA		SA	
	SAMP. DEPTH TOP	0 7		0 5		0 2		0 5		0 6		0 4		0 3	
	SAMP. DEPTH BOT:	0.9		0 7		0 4		0 7		0 8		0.6		0.6	
	MATRIX:	SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	4-Dec-97		5-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
VOLATILES															
1,1,1-Trichloroethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
1,1,2,2-Tetrachloroethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
1,1,2-Trichloroethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
1,1-Dichloroethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
1,1-Dichloroethene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
1,2-Dichloroethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
1,2-Dichloroethene (total)	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
1,2-Dichloropropane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Acetone	UG/KG	16	UJ	14	U	10	J	20	UJ	18	UJ	21	UJ	27	UJ
Benzene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Bromodichloromethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Bromoform	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Carbon disulfide	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Carbon tetrachloride	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Chlorobenzene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Chlorodibromomethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Chloroethane	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Chloroform	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Cis-1,3-Dichloropropene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Ethyl benzene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Methyl bromide	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Methyl butyl ketone	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Methyl chloride	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Methyl ethyl ketone	UG/KG	16	UJ	14	UJ	18	U	20	UJ	18	UJ	21	UJ	27	U
Methyl isobutyl ketone	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Methylene chloride	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Styrene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Tetrachloroethene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Toluene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Total Xylenes	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Trans-1,3-Dichloropropene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Trichloroethene	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
Vinyl chloride	UG/KG	16	U	14	U	18	U	20	U	18	U	21	U	27	U
SEMI-VOLATILES															
1,2-Dichlorobenzene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
1,3-Dichlorobenzene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
1,4-Dichlorobenzene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2,4,5-Trichlorophenol	UG/KG	300	U	210	U	360	U	360	U	310	U	240	U	530	U
2,4,6-Trichlorophenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2,4-Dichlorophenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2,4-Dimethylphenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2,4-Dinitrophenol	UG/KG	300	UJ	210	UJ	360	UJ	360	UJ	310	UJ	240	UJ	530	UJ
2,4-Dinitrotoluene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2,6-Dinitrotoluene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2-Chloronaphthalene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2-Chlorophenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2-Methylnaphthalene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2-Methylphenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
2-Nitroaniline	UG/KG	300	U	210	U	360	U	360	U	310	U	240	U	530	U
2-Nitrophenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
3,3'-Dichlorobenzidine	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
3-Nitroaniline	UG/KG	300	UJ	210	UJ	360	UJ	360	UJ	310	UJ	240	UJ	530	UJ
4,6-Dinitro-2-methylphenol	UG/KG	300	UJ	210	UJ	360	UJ	360	UJ	310	UJ	240	UJ	530	UJ
4-Bromophenyl phenyl ether	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
4-Chloro-3-methylphenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
4-Chloroaniline	UG/KG	120	UJ	88	UJ	150	UJ	150	UJ	130	UJ	100	UJ	220	UJ

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	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67668		67668		67668		67668		67668		67668		67668	
	LOC ID:	SWSD63-7		SWSD63-11		SWSD63-9		SWSD63-6		SWSD63-12		SWSD63-16		SWSD63-17	
	SAMP_ID:	63101		63102		63103		63104		63105		63106		63107	
	FIELD QC CODE	SA		SA		SA		SA		SA		SA		SA	
	SAMP DEPTH TOP	0.7		0.5		0.2		0.5		0.6		0.4		0.3	
	SAMP. DEPTH BOT:	0.9		0.7		0.4		0.7		0.8		0.6		0.6	
	MATRIX:	SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	4-Dec-97		5-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
4-Chlorophenyl phenyl ether	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
4-Methylphenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Acenaphthene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Acenaphthylene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Anthracene	UG/KG	120	U	7.3	J	150	U	150	U	130	U	100	U	19	J
Benzo(a)anthracene	UG/KG	13	J	51	J	15	J	12	J	9.5	J	8.1	J	130	J
Benzo(a)pyrene	UG/KG	21	J	58	J	22	J	15	J	12	J	10	J	170	J
Benzo(b)fluoranthene	UG/KG	37	J	120	J	23	J	33	J	14	J	15	J	240	
Benzo(ghi)perylene	UG/KG	12	J	44	J	18	J	11	J	9.4	J	12	J	150	J
Benzo(k)fluoranthene	UG/KG	120	U	88	U	17	J	150	U	14	J	9.9	J	150	J
Bis(2-Chloroethoxy)methane	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Bis(2-Chloroethyl)ether	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Bis(2-Chloroisopropyl)ether	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Bis(2-Ethylhexyl)phthalate	UG/KG	25	J	110	J	13	J	9.6	J	19	J	8.3	J	22	J
Butylbenzylphthalate	UG/KG	22	J	88	U	150	U	150	U	130	U	100	U	16	J
Carbazole	UG/KG	120	UJ	9.4	J	150	UJ	150	UJ	130	UJ	100	UJ	32	J
Chrysene	UG/KG	13	J	73	J	22	J	15	J	14	J	12	J	180	J
Di-n-butylphthalate	UG/KG	14	J	18	J	9.5	J	150	U	130	U	6.5	J	11	J
Di-n-octylphthalate	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Dibenz(a,h)anthracene	UG/KG	120	U	19	J	150	U	150	U	130	U	100	U	46	J
Dibenzofuran	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Diethyl phthalate	UG/KG	120	U	88	U	150	U	150	U	7.5	J	100	U	220	U
Dimethylphthalate	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Fluoranthene	UG/KG	32	J	100		31	J	28	J	23	J	18	J	360	
Fluorene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Hexachlorobenzene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Hexachlorobutadiene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Hexachlorocyclopentadiene	UG/KG	120	UJ	88	UJ	150	UJ	150	UJ	130	UJ	100	UJ	220	UJ
Hexachloroethane	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Indeno(1,2,3-cd)pyrene	UG/KG	12	J	37	J	14	J	11	J	9.2	J	8.2	J	140	J
Isophorone	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
N-Nitrosodiphenylamine	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
N-Nitrosodipropylamine	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Naphthalene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Nitrobenzene	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Pentachlorophenol	UG/KG	300	UJ	210	UJ	360	U	360	U	310	U	240	U	530	U
Phenanthrene	UG/KG	14	J	51	J	12	J	12	J	11	J	6	J	120	J
Phenol	UG/KG	120	U	88	U	150	U	150	U	130	U	100	U	220	U
Pyrene	UG/KG	23	J	80	J	24	J	19	J	18	J	14	J	240	
PESTICIDES/PCBs															
4,4'-DDD	UG/KG	6.2	U	4.4	U	7.3	U	7.3	U	6.3	U	5	U	11	U
4,4'-DDE	UG/KG	6.2	U	4.4	U	7.3	U	7.3	U	6.3	U	5	U	11	U
4,4'-DDT	UG/KG	6.2	U	4.4	U	7.3	U	7.3	U	6.3	U	5	U	11	U
Aldrin	UG/KG	3.2	U	2.3	U	3.8	U	3.8	U	3.3	U	2.6	U	5.7	U
Alpha-BHC	UG/KG	3.2	U	2.3	U	3.8	U	3.8	U	3.3	U	2.6	U	5.7	U
Alpha-Chlordane	UG/KG	3.2	U	2.3	U	3.8	U	3.8	U	3.3	U	2.6	U	5.7	U
Aroclor-1016	UG/KG	62	U	44	U	73	U	73	U	63	U	50	U	110	U
Aroclor-1221	UG/KG	130	U	89	U	150	U	150	U	130	U	100	U	220	U
Aroclor-1232	UG/KG	62	U	44	U	73	U	73	U	63	U	50	U	110	U
Aroclor-1242	UG/KG	62	U	44	U	73	U	73	U	63	U	50	U	110	U
Aroclor-1248	UG/KG	62	U	44	U	73	U	73	U	63	U	50	U	110	U
Aroclor-1254	UG/KG	62	U	44	U	73	U	73	U	63	U	50	U	110	U
Aroclor-1260	UG/KG	62	U	44	U	73	U	73	U	63	U	50	U	110	U
Beta-BHC	UG/KG	3.2	U	2.3	U	3.8	U	3.8	U	3.3	U	2.6	U	5.7	U
Delta-BHC	UG/KG	3.2	U	2.3	U	3.8	U	3.8	U	3.3	U	2.6	U	5.7	U
Dieldrin	UG/KG	6.2	U	4.4	U	7.3	U	7.3	U	6.3	U	5	U	11	U
Endosulfan I	UG/KG	3.2	U	2.3	U	3.8	U	3.8	U	3.3	U	2.6	U	5.7	U

TABLE D-7
SEDIMENT DATA
SEAD-63

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67668		67668		67668		67668		67668		67668		67668	
	LOC ID:	SWSD63-7		SWSD63-11		SWSD63-9		SWSD63-6		SWSD63-12		SWSD63-16		SWSD63-17	
	SAMP_ID:	63101		63102		63103		63104		63105		63106		63107	
	FIELD QC CODE:	SA		SA		SA		SA		SA		SA		SA	
	SAMP. DEPTH TOP:	0 7		0 5		0 2		0 5		0 6		0.4		0 3	
	SAMP. DEPTH BOT.	0 9		0.7		0 4		0 7		0 8		0.6		0.6	
	MATRIX	SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	4-Dec-97		5-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
Endosulfan II	UG/KG	6.2	U	4 4	U	7 3	U	7 3	U	6 3	U	5.	U	11.	U
Endosulfan sulfate	UG/KG	6.2	U	4.4	U	7.3	U	7 3	U	6 3	U	5.	U	11	U
Endrin aldehyde	UG/KG	6.2	U	4 4	U	7 3	U	7 3	U	6 3	U	5.	U	11.	U
Endrin ketone	UG/KG	6 2	U	4 4	U	7 3	U	7 3	U	6 3	U	5.	U	11.	U
Gamma-BHC/Lindane	UG/KG	3.2	U	2 3	U	3 8	U	3 8	U	3 3	U	2.6	U	5 7	U
Gamma-Chlordane	UG/KG	3 2	U	2 3	U	3 8	U	3 8	U	3 3	U	2.6	U	5.7	U
Heptachlor	UG/KG	3 2	U	2 3	U	3 8	U	3 8	U	3 3	U	2 6	U	5.7	U
Heptachlor epoxide	UG/KG	3 2	U	2 3	U	3 8	U	3 8	U	3.3	U	2.6	U	5.7	U
Methoxychlor	UG/KG	32.	U	23.	U	38.	U	38.	U	33.	U	26.	U	57.	U
Toxaphene	UG/KG	320	U	230	U	380	U	380.	U	330.	U	260.	U	570.	U
METALS															
Aluminum	MG/KG	9,770		2,030		11,600		11,900.		13,000.		12,600.		12,300.	
Antimony	MG/KG	.92	UJ	.9	UJ	1 5	UJ	1 5	UJ	.96	UJ	.97	UJ	2.2	UJ
Arsenic	MG/KG	2.9		2.3	J	4.7		4 1	J	4.6		5.2		6.8	
Barium	MG/KG	68.1		19 9	J	85 1	J	76 2	J	90.5		64.		105.	J
Beryllium	MG/KG	.51	J	.11	J	.64	J	63	J	.65	J	.59	J	.47	J
Cadmium	MG/KG	.08	U	.08	U	13	U	.13	U	.08	U	.08	U	.19	U
Calcium	MG/KG	2,090.		139,000.		7,050		2,650.		3,370.		14,400.		55,600.	
Chromium	MG/KG	15.		4.1		18 4		18 5		16 8		21.8		22.4	
Cobalt	MG/KG	7.9	J	3 2	J	10.7	J	7 6	J	8.5	J	12.7	J	14.4	J
Copper	MG/KG	15.9		8.7		24 7		20 4		21.9		32.		42 6	
Cyanide	MG/KG	1.1	UJ	2.1	J	1.1	UJ	1 2	UJ	.96	UJ	.76	UJ	1.7	UJ
Iron	MG/KG	16,300.		4,790.		21,800.		16,700.		20,100.		26,000.		24,700.	
Lead	MG/KG	17.6	J	8 6	J	25.5	J	23 2	J	24.6	J	20.8	J	41.5	J
Magnesium	MG/KG	2,610.		9,380.		5,010		3,260		3,330.		5,400.		14,600.	
Manganese	MG/KG	431.		225.		284		222.		344.		346.		760.	
Mercury	MG/KG	.08	J	.05	UJ	.11	UJ	.11	UJ	.13	J	.06	UJ	.16	UJ
Nickel	MG/KG	18.4		8 8	J	29 4		22 7		25		42.		39.6	
Potassium	MG/KG	1,120.	J	597.	J	1,530.	J	1,580	J	1,580.		1,460.		2,350.	J
Selenium	MG/KG	1.2	U	1 2	U	2	U	2	U	1.3	U	1.3	U	3.	U
Silver	MG/KG	.55	U	.54	U	9	U	89	U	.58	U	.58	U	1.3	U
Sodium	MG/KG	234.	J	323.	J	285	J	298.	J	235	J	221.	J	578.	J
Thallium	MG/KG	1.6	UJ	1.6	J	2.7	UJ	2.7	UJ	1.7	UJ	1.7	UJ	4.	UJ
Vanadium	MG/KG	17 1		10 9	J	20 4	J	20 7	J	21.3		19 6		26.9	J
Zinc	MG/KG	52.3	J	37.2	J	79.2	J	65 8	J	69 4	J	73.4	J	295.	J

1.

SEDIME. ATA
SEAD-63

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67668		67668		67668	
	LOC ID.	SWSD63-18		SWSD63-19		SWSD63-20	
	SAMP_ID	63108		63109		63110	
	FIELD QC CODE:	SA		SA		SA	
	SAMP. DEPTH TOP:	0 2		0 4		0 3	
	SAMP DEPTH BOT:	0 4		0 6		0 5	
	MATRIX	SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP DATE:	11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q
VOLATILES							
1,1,1-Trichloroethane	UG/KG	17	U	18	U	16	U
1,1,2,2-Tetrachloroethane	UG/KG	17	U	18	U	16	U
1,1,2-Trichloroethane	UG/KG	17	U	18	U	16	U
1,1-Dichloroethane	UG/KG	17	U	18	U	16	U
1,1-Dichloroethene	UG/KG	17	U	18	U	16	U
1,2-Dichloroethane	UG/KG	17	U	18	U	16	U
1,2-Dichloroethene (total)	UG/KG	17	U	18	U	16	U
1,2-Dichloropropane	UG/KG	17	U	18	U	16	U
Acetone	UG/KG	35	J	9	J	17	J
Benzene	UG/KG	17	U	18	U	16	U
Bromodichloromethane	UG/KG	17	U	18	U	16	U
Bromoform	UG/KG	17	U	18	U	16	U
Carbon disulfide	UG/KG	17	U	18	U	16	U
Carbon tetrachloride	UG/KG	17	U	18	U	16	U
Chlorobenzene	UG/KG	17	U	18	U	16	U
Chlorodibromomethane	UG/KG	17	U	18	U	16	U
Chloroethane	UG/KG	17	U	18	U	16	U
Chloroform	UG/KG	17	U	18	U	16	U
Cis-1,3-Dichloropropene	UG/KG	17	U	18	U	16	U
Ethyl benzene	UG/KG	17	U	18	U	16	U
Methyl bromide	UG/KG	17	U	18	U	16	U
Methyl butyl ketone	UG/KG	17	U	18	U	16	U
Methyl chloride	UG/KG	17	U	18	U	16	U
Methyl ethyl ketone	UG/KG	17	U	18	U	16	U
Methyl isobutyl ketone	UG/KG	17	U	18	U	16	U
Methylene chloride	UG/KG	17	U	18	U	16	U
Styrene	UG/KG	17	U	18	U	16	U
Tetrachloroethene	UG/KG	17	U	18	U	16	U
Toluene	UG/KG	17	U	18	U	16	U
Total Xylenes	UG/KG	17	U	18	U	16	U
Trans-1,3-Dichloropropene	UG/KG	17	U	18	U	16	U
Trichloroethene	UG/KG	17	U	18	U	16	U
Vinyl chloride	UG/KG	17	U	18	U	16	U
SEMI-VOLATILES							
1,2-Dichlorobenzene	UG/KG	120	U	150	U	100	U
1,3-Dichlorobenzene	UG/KG	120	U	150	U	100	U
1,4-Dichlorobenzene	UG/KG	120	U	150	U	100	U
2,4,5-Trichlorophenol	UG/KG	280	U	370	U	250	U
2,4,6-Trichlorophenol	UG/KG	120	U	150	U	100	U
2,4-Dichlorophenol	UG/KG	120	U	150	U	100	U
2,4-Dimethylphenol	UG/KG	120	U	150	U	100	U
2,4-Dinitrophenol	UG/KG	280	UJ	370	UJ	250	UJ
2,4-Dinitrotoluene	UG/KG	120	U	150	U	100	U
2,6-Dinitrotoluene	UG/KG	120	U	150	U	100	U
2-Chloronaphthalene	UG/KG	120	U	150	U	100	U
2-Chlorophenol	UG/KG	120	U	150	U	100	U
2-Methylnaphthalene	UG/KG	12	J	14	J	100	U
2-Methylphenol	UG/KG	120	U	150	U	100	U
2-Nitroaniline	UG/KG	280	U	370	U	250	U
2-Nitrophenol	UG/KG	120	U	150	U	100	U
3,3'-Dichlorobenzidine	UG/KG	120	U	150	U	100	U
3-Nitroaniline	UG/KG	280	UJ	370	UJ	250	UJ
4,6-Dinitro-2-methylphenol	UG/KG	280	UJ	370	UJ	250	UJ
4-Bromophenyl phenyl ether	UG/KG	120	U	150	U	100	U
4-Chloro-3-methylphenol	UG/KG	120	U	150	U	100	U
4-Chloroaniline	UG/KG	120	UJ	150	UJ	100	UJ

TABLE D-7
SEDIMENT DATA
SEAD-63

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67668		67668		67668	
	LOC ID:	SWSD63-18		SWSD63-19		SWSD63-20	
	SAMP_ID:	63108		63109		63110	
	FIELD QC CODE:	SA		SA		SA	
	SAMP. DEPTH TOP:	0.2		0.4		0.3	
	SAMP. DEPTH BOT:	0.4		0.6		0.5	
	MATRIX:	SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q
4-Chlorophenyl phenyl ether	UG/KG	120	U	150	U	100	U
4-Methylphenol	UG/KG	120	U	150	U	100	U
Acenaphthene	UG/KG	43	J	80	J	8.2	J
Acenaphthylene	UG/KG	17	J	82	J	9.1	J
Anthracene	UG/KG	93	J	250		17	J
Benzo(a)anthracene	UG/KG	660		1,800	J	180	
Benzo(a)pyrene	UG/KG	790		2,900	J	200	
Benzo(b)fluoranthene	UG/KG	2,000	J	5,300	J	240	
Benzo(ghi)perylene	UG/KG	750		2,700	J	180	
Benzo(k)fluoranthene	UG/KG	870		770	UJ	200	
Bis(2-Chloroethoxy)methane	UG/KG	120	U	150	U	100	U
Bis(2-Chloroethyl)ether	UG/KG	120	U	150	U	100	U
Bis(2-Chloroisopropyl)ether	UG/KG	120	U	150	U	100	U
Bis(2-Ethylhexyl)phthalate	UG/KG	16	J	20	J	12	J
Butylbenzylphthalate	UG/KG	120	U	150	U	100	U
Carbazole	UG/KG	260	J	430	J	28	J
Chrysene	UG/KG	840		2,300	J	220	
Di-n-butylphthalate	UG/KG	120	U	150	U	100	U
Di-n-octylphthalate	UG/KG	120	U	150	U	100	U
Dibenz(a,h)anthracene	UG/KG	250		1,200		84	J
Dibenzofuran	UG/KG	36	J	35	J	100	U
Diethyl phthalate	UG/KG	120	U	150	U	100	U
Dimethylphthalate	UG/KG	120	U	150	U	100	U
Fluoranthene	UG/KG	1,700	J	4,100	J	400	
Fluorene	UG/KG	79	J	110	J	10	J
Hexachlorobenzene	UG/KG	120	U	150	U	100	U
Hexachlorobutadiene	UG/KG	120	U	150	U	100	U
Hexachlorocyclopentadiene	UG/KG	120	UJ	150	UJ	100	UJ
Hexachloroethane	UG/KG	120	U	150	U	100	U
Indeno(1,2,3-cd)pyrene	UG/KG	800		2,500	J	170	
Isophorone	UG/KG	120	U	150	U	100	U
N-Nitrosodiphenylamine	UG/KG	120	U	150	U	100	U
N-Nitrosodipropylamine	UG/KG	120	U	150	U	100	U
Naphthalene	UG/KG	21	J	23	J	100	U
Nitrobenzene	UG/KG	120	U	150	U	100	U
Pentachlorophenol	UG/KG	280	U	370	U	250	U
Phenanthrene	UG/KG	940		1,400	J	120	
Phenol	UG/KG	120	U	150	U	100	U
Pyrene	UG/KG	1,300	J	3,200	J	290	
PESTICIDES/PCBs							
4,4'-DDD	UG/KG	5.9	U	7.7	U	5.2	U
4,4'-DDE	UG/KG	5.9	U	7.7	U	5.2	U
4,4'-DDT	UG/KG	5.9	U	12	U	5.2	U
Aldrin	UG/KG	3	U	4	U	2.6	U
Alpha-BHC	UG/KG	3	U	4	U	2.6	U
Alpha-Chlordane	UG/KG	3	U	4	U	2.6	U
Aroclor-1016	UG/KG	59	U	77	U	52	U
Aroclor-1221	UG/KG	120	U	160	U	100	U
Aroclor-1232	UG/KG	59	U	77	U	52	U
Aroclor-1242	UG/KG	59	U	77	U	52	U
Aroclor-1248	UG/KG	59	U	77	U	52	U
Aroclor-1254	UG/KG	59	U	77	U	52	U
Aroclor-1260	UG/KG	59	U	77	U	52	U
Beta-BHC	UG/KG	3	U	4	U	2.6	U
Delta-BHC	UG/KG	3	U	4	U	2.6	U
Dieldrin	UG/KG	5.9	U	7.7	U	5.2	U
Endosulfan I	UG/KG	3	U	4	U	2.6	U

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67668		67668		67668	
	LOC ID:	SWSD63-18		SWSD63-19		SWSD63-20	
	SAMP_ID	63108		63109		63110	
	FIELD OC CODE:	SA		SA		SA	
	SAMP DEPTH TOP:	0 2		0 4		0 3	
	SAMP DEPTH BOT:	0 4		0 6		0.5	
	MATRIX:	SEDIMENT		SEDIMENT		SEDIMENT	
	SAMP. DATE:	11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q
Endosulfan II	UG/KG	5 9	U	7 7	U	5 2	U
Endosulfan sulfate	UG/KG	5 9	U	12		6 1	U
Endrin aldehyde	UG/KG	5 9	U	6 6	U	5 2	U
Endrin ketone	UG/KG	5.9	U	12	U	3 9	UJ
Gamma-BHC/Lindane	UG/KG	3	U	4	U	2 6	U
Gamma-Chlordane	UG/KG	3	U	4	U	2 6	U
Heptachlor	UG/KG	3	U	4	U	2 6	U
Heptachlor epoxide	UG/KG	3	U	4	U	2 6	U
Methoxychlor	UG/KG	30	U	40	U	26	U
Toxaphene	UG/KG	300	U	400	U	260	U
METALS							
Aluminum	MG/KG	10,900		11,000		6,320	
Antimony	MG/KG	1 1	UJ	1 5	UJ	1.	UJ
Arsenic	MG/KG	4 1		5 7		3 6	
Barium	MG/KG	59 8	J	61 3	J	34 7	J
Beryllium	MG/KG	.48	J	28	J	29	J
Cadmium	MG/KG	1	U	13	U	09	U
Calcium	MG/KG	34,800		43,300		90,000	
Chromium	MG/KG	17 5		18 8		12	
Cobalt	MG/KG	9 3	J	12	J	7.5	J
Copper	MG/KG	28 8		31 2		20.2	
Cyanide	MG/KG	92	UJ	1 2	UJ	78	UJ
Iron	MG/KG	17,800		20,900		12,600	
Lead	MG/KG	31 2	J	46 2	J	19 6	J
Magnesium	MG/KG	6,280		9,980		9,640	
Manganese	MG/KG	344		995		315	
Mercury	MG/KG	07	UJ	1	UJ	06	UJ
Nickel	MG/KG	30.1		33 7		21 1	
Potassium	MG/KG	2,290		2,000	J	1,360.	J
Selenium	MG/KG	1 5	U	2 1	U	1 4	U
Silver	MG/KG	67	U	93	U	62	U
Sodium	MG/KG	383	J	543	J	312	J
Thallium	MG/KG	2	UJ	2 8	UJ	1 8	UJ
Vanadium	MG/KG	21 2		28		15 5	
Zinc	MG/KG	90 6	J	534.	J	120.	J

T 8
SURFAC ER DATA
S 43

						See Note 1		See Note 1				See Note 1				
	STUDY ID.	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1
	SDG:	67745		67745		67745		67745		67745		67745		67745		67669
	LOC ID:	SWSD63-14		SWSD63-14		SWSD63-10		SWSD63-15		SWSD63-8		SWSD63-5		SWSD63-13		SWSD63-7
	SAMP_ID:	12216		63011		63012		63013		63014		63015		63016		12214
	FIELD QC CODE:	DU		SA		SA		SA		SA		SA		SA		DU
	SAMP. DEPTH TOP:	0		0		0		0		0		0		0		0
	SAMP. DEPTH BOT:	0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1
	MATRIX:	SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER
	SAMP. DATE	12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		13-Dec-97		4-Dec-97
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALU
VOLATILES																
1,1,1-Trichloroethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
1,1,2,2-Tetrachloroethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
1,1,2-Trichloroethane	UG/L	1.	U	1.	U	1	U	1.	U	1.	U	1.	U	1.	U	1
1,1-Dichloroethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
1,1-Dichloroethene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
1,2-Dibromo-3-chloropropane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
1,2-Dibromoethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
1,2-Dichlorobenzene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
1,2-Dichloroethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
1,2-Dichloropropane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
1,3-Dichlorobenzene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
1,4-Dichlorobenzene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
Acetone	UG/L	5.	U	5.	U	5	U	5.	U	5.	U	5.	U	5.	U	5.
Benzene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
Bromochloromethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Bromodichloromethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
Bromoform	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Carbon disulfide	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Carbon tetrachloride	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Chlorobenzene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
Chlorodibromomethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Chloroethane	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Chloroform	UG/L	1.	U	1.	U	1.	U	1.	U	.8	J	1.	U	1.	U	1
Cis-1,2-Dichloroethene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
Cis-1,3-Dichloropropene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
Ethyl benzene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Methyl bromide	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Methyl butyl ketone	UG/L	5.	U	5.	U	5	U	5	U	5.	U	5.	U	5.	U	5
Methyl chloride	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Methyl ethyl ketone	UG/L	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U	5
Methyl isobutyl ketone	UG/L	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U	5
Methylene chloride	UG/L	2.	U	2.	U	2.	U	2.	U	2.	U	2.	U	2.	U	2.
Styrene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Tetrachloroethene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Toluene	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.
Total Xylenes	UG/L	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
Trans-1,2-Dichloroethene	UG/L	1.	U	1.	U	1.	U	1	U	1.	U	1.	U	1.	U	1
Trans-1,3-Dichloropropene	UG/L	1.	U	1.	U	1.	U	1	U	1.	U	1.	U	1.	U	1
Trichloroethene	UG/L	1.	U	1.	U	1	U	1.	U	1.	U	1.	U	1.	U	1.
Vinyl chloride	UG/L	1.	U	1	U	1.	U	1.	U	1.	U	1.	U	1.	U	1
SEMI-VOLATILES																
1,2-Dichlorobenzene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
1,3-Dichlorobenzene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
1,4-Dichlorobenzene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2,4,5-Trichlorophenol	UG/L	2.7	U	2.7	U	3.1	U	2.8	U	2.9	U	2.5	U	2.7	U	2.8
2,4,6-Trichlorophenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2,4-Dichlorophenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2,4-Dimethylphenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2,4-Dinitrophenol	UG/L	2.7	UJ	2.7	UJ	3.1	UJ	2.8	UJ	2.8	UJ	2.5	UJ	2.7	UJ	2.8
2,4-Dinitrotoluene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2,6-Dinitrotoluene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2-Chloronaphthalene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2-Chlorophenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2-Methylnaphthalene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
2-Methylphenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1	U	1.1	U	1.1
2-Nitroaniline	UG/L	2.7	U	2.7	U	3.1	U	2.8	U	2.9	U	2.5	U	2.7	U	2.8
2-Nitrophenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
3,3'-Dichlorobenzidine	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
3-Nitroaniline	UG/L	2.7	UJ	2.7	UJ	3.1	UJ	2.8	UJ	2.9	UJ	2.5	UJ	2.7	UJ	2.8

Note 1. Reextracted Results Used for PCBs/Pesticides

TABLE D-8
SURFACE WATER DATA
SEAD-63

						See Note 1		See Note 1				See Note 1				
	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1
	SDG:	67745		67745		67745		67745		67745		67745		67745		67669
	LOC ID:	SWSD63-14		SWSD63-14		SWSD63-10		SWSD63-15		SWSD63-8		SWSD63-5		SWSD63-13		SWSD63-7
	SAMP_ID:	12216		63011		63012		63013		63014		63015		63016		12214
	FIELD QC CODE:	DU		SA		SA		SA		SA		SA		SA		DU
	SAMP. DEPTH TOP:	0		0		0		0		0		0		0		0
	SAMP. DEPTH BOT:	0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1
	MATRIX:	SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER
	SAMP. DATE:	12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		13-Dec-97		4-Dec-97
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALU
4,6-Dinitro-2-methylphenol	UG/L	2.7	U	2.7	U	3.1	U	2.8	U	2.9	U	2.5	U	2.7	U	2.8
4-Bromophenyl phenyl ether	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
4-Chloro-3-methylphenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
4-Chloroaniline	UG/L	1.1	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.	UJ	1.1	UJ	1.1
4-Chlorophenyl phenyl ether	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
4-Methylphenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Acenaphthene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Acenaphthylene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Anthracene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Benzo(a)anthracene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Benzo(a)pyrene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Benzo(b)fluoranthene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Benzo(ghi)perylene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Benzo(k)fluoranthene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Bis(2-Chloroethoxy)methane	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Bis(2-Chloroethyl)ether	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Bis(2-Chloroisopropyl)ether	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Bis(2-Ethylhexyl)phthalate	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.1	U	1.1	U	1.1
Butylbenzylphthalate	UG/L	1.1	U	.19	J	.21	J	.19	J	1.2	U	1.	U	1.1	U	.092
Carbazole	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Chrysene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Di-n-butylphthalate	UG/L	1.1	U	.082	J	.078	J	.14	J	.095	J	1.	U	.13	J	.071
Di-n-octylphthalate	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Dibenz(a,h)anthracene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Dibenzofuran	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Diethyl phthalate	UG/L	1.1	U	1.1	U	1.2	U	.059	J	1.2	U	1.	U	1.1	U	.093
Dimethylphthalate	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Fluoranthene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Fluorene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Hexachlorobenzene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Hexachlorobutadiene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Hexachlorocyclopentadiene	UG/L	1.1	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.	UJ	1.1	UJ	1.1
Hexachloroethane	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Indeno(1,2,3-cd)pyrene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Isophorone	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
N-Nitrosodiphenylamine	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
N-Nitrosodipropylamine	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Naphthalene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Nitrobenzene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Pentachlorophenol	UG/L	2.7	UJ	2.7	UJ	3.1	UJ	2.8	UJ	2.9	UJ	2.5	UJ	2.7	UJ	2.8
Phenanthrene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Phenol	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
Pyrene	UG/L	1.1	U	1.1	U	1.2	U	1.1	U	1.2	U	1.	U	1.1	U	1.1
PESTICIDES/PCBs																
4,4'-DDD	UG/L	.012	U	.012	U	.01	UJ	.01	UJ	.01	U	.01	UJ	.01	U	.026
4,4'-DDE	UG/L	.012	U	.012	U	.01	UJ	.01	UJ	.01	U	.01	UJ	.01	U	.005
4,4'-DDT	UG/L	.012	UJ	.012	UJ	.01	UJ	.01	UJ	.01	UJ	.01	UJ	.01	UJ	.01
Aldrin	UG/L	.006	UJ	.006	UJ	.005	UJ	.005	UJ	.005	UJ	.005	UJ	.005	UJ	.005
Alpha-BHC	UG/L	.006	U	.006	U	.005	UJ	.005	UJ	.005	U	.005	UJ	.005	U	.005
Alpha-Chlordane	UG/L	.006	U	.006	U	.005	UJ	.005	UJ	.005	U	.005	UJ	.005	U	.005
Aroclor-1016	UG/L	.12	U	.12	U	.1	UJ	.1	UJ	.1	U	.1	UJ	.1	U	.1
Aroclor-1221	UG/L	.24	U	.24	U	2	UJ	.21	UJ	.21	U	.21	UJ	.2	U	.21
Aroclor-1232	UG/L	.12	U	.12	U	.1	UJ	.1	UJ	.1	U	.1	UJ	.1	U	.1
Aroclor-1242	UG/L	.12	U	.12	U	.1	UJ	.1	UJ	.1	U	.1	UJ	.1	U	.1
Aroclor-1248	UG/L	.12	U	.12	U	.1	UJ	.1	UJ	.1	U	.1	UJ	.1	U	.1
Aroclor-1254	UG/L	.12	U	.12	U	.1	UJ	.1	UJ	.1	U	.1	UJ	.1	U	.1
Aroclor-1260	UG/L	.12	U	.12	U	.1	UJ	.1	UJ	.1	U	.1	UJ	.1	U	.1
Beta-BHC	UG/L	.006	U	.006	U	.005	UJ	.005	UJ	.005	U	.005	UJ	.005	U	.005
Delta-BHC	UG/L	.006	U	.006	U	.005	UJ	.005	UJ	.005	U	.005	UJ	.005	U	.005
Dieldrin	UG/L	.012	UJ	.012	UJ	.01	UJ	.01	UJ	.01	UJ	.01	UJ	.01	UJ	.01

Note 1: Reextracted Results Used for PCBs/Pesticides

1 8
SURFAC :R DATA
SEAU-63

						See Note 1		See Note 1				See Note 1				
	STUDY ID	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1
	SDG	67745		67745		67745		67745		67745		67745		67745		67669
	LOC ID:	SWSD63-14		SWSD63-14		SWSD63-10		SWSD63-15		SWSD63-8		SWSD63-5		SWSD63-13		SWSD63-7
	SAMP_ID:	12216		63011		63012		63013		63014		63015		63016		12214
	FIELD QC CODE:	DU		SA		SA		SA		SA		SA		SA		DU
	SAMP. DEPTH TOP:	0		0		0		0		0		0		0		0
	SAMP. DEPTH BOT:	0.1		0.1		0 1		0.1		0.1		0.1		0.1		0 1
	MATRIX:	SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER
	SAMP. DATE:	12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		13-Dec-97		4-Dec-97
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALU
Endosulfan I	UG/L	.006	U	.006	U	.005	UJ	.005	UJ	.005	U	.005	UJ	.005	U	005
Endosulfan II	UG/L	.012	U	.012	U	.01	UJ	.01	UJ	.01	U	.01	UJ	.01	U	.01
Endosulfan sulfate	UG/L	.012	U	.012	U	.01	UJ	.01	UJ	.01	U	.01	UJ	.01	U	.01
Endrin aldehyde	UG/L	.012	U	.012	U	.01	UJ	.01	UJ	.01	U	.01	UJ	.01	U	.01
Endrin ketone	UG/L	.012	U	012	U	01	UJ	.01	UJ	.01	U	.01	UJ	.01	U	.01
Gamma-BHC/Lindane	UG/L	.006	UJ	.006	UJ	.005	UJ	.005	UJ	.005	UJ	.005	UJ	.005	UJ	.005
Gamma-Chlordane	UG/L	.006	U	.006	U	.005	UJ	.005	UJ	.005	U	.005	UJ	.005	U	.01
Heptachlor	UG/L	.006	UJ	.006	UJ	.005	UJ	.005	UJ	.005	UJ	.005	UJ	.005	UJ	005
Heptachlor epoxide	UG/L	.006	U	.006	U	.005	UJ	.005	UJ	.005	U	.005	UJ	.005	U	.005
Hexachlorobenzene	UG/L	.012	UJ	012	UJ	.01	UJ	.01	UJ	.01	UJ	.01	UJ	.01	UJ	.01
Methoxychlor	UG/L	.059	U	.059	U	.05	UJ	.053	UJ	.052	U	.053	UJ	.051	U	.053
Toxaphene	UG/L	.59	U	.59	U	.5	UJ	.53	UJ	.52	U	.53	UJ	.51	U	53
METALS																
Aluminum	UG/L	12.3	U	12.3	U	12 3	U	301.		25.9	J	373.		12.3	U	142.
Antimony	UG/L	3.5	U	3 5	U	3 5	U	3.5	U	3.5	U	3.5	U	3.5	U	3.5
Arsenic	UG/L	3.6	U	3 6	U	3 6	U	3.6	U	3.6	U	3 6	U	3.6	U	3.6
Barium	UG/L	26.5	J	27 4	J	27.4	J	29.3	J	26.9	J	12.9	J	26.	J	16 5
Beryllium	UG/L	.1	U	.1	U	.1	U	.1	U	.1	U	.1	U	.1	U	.1
Cadmium	UG/L	.3	U	.3	U	.3	U	.3	U	.3	U	.3	U	.3	U	.3
Calcium	UG/L	126,000.		128,000.		95,200.		88,200.		74,200.		40,100.		72,500.		26,100
Chromium	UG/L	1.1	U	1 1	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1
Cobalt	UG/L	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1 7
Copper	UG/L	2.3	U	2 3	U	2.3	U	2.3	U	2.3	U	2.3	U	2.3	U	2.3
Cyanide	UG/L	5.	UJ	5.	UJ	5.	UJ	5.	UJ	5.	UJ	5.	UJ	5.	UJ	5
Iron	UG/L	25.6	U	25 6	U	25.6	U	403		82.	J	552.		49.8	J	150
Lead	UG/L	1.8	U	1.8	U	1.8	U	1 8	U	1.8	U	1.9	J	1.8	U	1 8
Magnesium	UG/L	19,800.		20,200.		13,300.		12,700.		8,080.		6,080.		10,600.		5,460
Manganese	UG/L	3.6	J	3.7	J	.83	J	7.7	J	47.2		89.		48.5		198
Mercury	UG/L	.1	U	.1	U	.1	U	.1	U	.1	U	.1	U	.1	U	1
Nickel	UG/L	2.1	U	2.1	U	2.1	U	2.1	U	2.1	U	2.1	U	2.1	U	3.7
Potassium	UG/L	2,840.	J	3,160.	J	5,900.		5,690.		4,810	J	1,660.	J	1,970.	J	4,980
Selenium	UG/L	4.7	U	4.7	U	4 7	U	4.7	U	4.7	U	4.7	U	4.7	U	4 7
Silver	UG/L	2.1	U	2.1	U	2 1	U	2.1	U	2.1	U	2.1	U	2.1	U	2.1
Sodium	UG/L	12,600.		13,100		22,400.		26,700.		12,300.		19,200.		2,440.	J	2,320
Thallium	UG/L	6.3	U	6 3	U	6 3	U	6.3	U	6.3	U	6.3	U	6.3	U	6 3
Vanadium	UG/L	1.6	U	1 6	U	1 6	U	1 6	U	1 6	U	1.6	U	1.6	U	1 6
Zinc	UG/L	15.9	J	13 2	J	10.3	J	24.9		11.5	J	30.3		86.2		8 6

Note 1. Reextracted Results Used for PCBs/Pesticides

TABLE D-8
SURFACE WATER DATA
SEAD-63

	STUDY ID:		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:		67669		67669		67669		67669		67669		67669		67669	
	LOC ID:		SWSD63-7		SWSD63-11		SWSD63-9		SWSD63-6		SWSD63-12		SWSD63-16		SWSD63-17	
	SAMP_ID:		63001		63002		63003		63004		63005		63006		63007	
	FIELD QC CODE:		SA		SA		SA		SA		SA		SA		SA	
	SAMP. DEPTH TOP:		0		0		0		0		0		0		0	
	SAMP. DEPTH BOT:		0.1		0.1		0.1		0.1		0.1		0.1		0.1	
	MATRIX:		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER	
	SAMP. DATE:		4-Dec-97		5-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
VOLATILES																
1,1,1-Trichloroethane	UG/L	U	1.	U	1	U	1.	U	1.	U	1.	U	1	U	1	U
1,1,2,2-Tetrachloroethane	UG/L	U	1	U	1	U	1.	U	1	U	1.	U	1.	U	1.	U
1,1,2-Trichloroethane	UG/L	U	1	U	1.	U	1.	U	1.	U	1.	U	1	U	1.	U
1,1-Dichloroethane	UG/L	U	1	U	1	U	1.	U	1.	U	1.	U	1.	U	1.	U
1,1-Dichloroethene	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
1,2-Dibromo-3-chloropropane	UG/L	U	1	U	1	U	1.	U	1	U	1.	U	1.	U	1.	U
1,2-Dibromoethane	UG/L	U	1	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
1,2-Dichlorobenzene	UG/L	U	1.	U	1	U	1.	U	1	U	1.	U	1.	U	1.	U
1,2-Dichloroethane	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
1,2-Dichloropropane	UG/L	U	1.	U	1	U	1.	U	1	U	1.	U	1.	U	1.	U
1,3-Dichlorobenzene	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
1,4-Dichlorobenzene	UG/L	U	1.	U	1	U	1.	U	1.	U	1.	U	1.	U	1	U
Acetone	UG/L	U	5.	U	5	U	5.	U	5	U	5.	U	5.	U	5.	U
Benzene	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Bromochloromethane	UG/L	U	1	U	1.	U	1.	U	1	U	1.	U	1.	U	1.	U
Bromodichloromethane	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Bromoform	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Carbon disulfide	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Carbon tetrachloride	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Chlorobenzene	UG/L	U	1.	U	1	U	1.	U	1.	U	1.	U	1.	U	1.	U
Chlorodibromomethane	UG/L	U	1.	U	1.	U	1	U	1.	U	1.	U	1.	U	1.	U
Chloroethane	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Chloroform	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	.5	J	1.	U
Cis-1,2-Dichloroethene	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Cis-1,3-Dichloropropene	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Ethyl benzene	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Methyl bromide	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Methyl butyl ketone	UG/L	U	5.	U	5.	U	5	U	5.	U	5	U	5.	U	5	U
Methyl chloride	UG/L	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U	1.	U
Methyl ethyl ketone	UG/L	U	5.	U	5	U	5.	U	5	U	5.	U	5.	U	5.	U
Methyl isobutyl ketone	UG/L	U	5	U	5	U	5	U	5	U	5.	U	5.	U	5.	U
Methylene chloride	UG/L	U	2.	U	2.	U	2.	U	2.	U	2.	U	2.	U	2.	U
Styrene	UG/L	U	1.	U	1.	U	1	U	1.	U	1.	U	1.	U	1.	U
Tetrachloroethene	UG/L	U	1.	U	1.	U	1	U	1.	U	1.	U	1.	U	1.	U
Toluene	UG/L	U	1.	U	1.	U	1	U	1	U	1.	U	1.	U	1.	U
Total Xylenes	UG/L	U	1	U	1.	U	1	U	1	U	1	U	1.	U	1.	U
Trans-1,2-Dichloroethene	UG/L	U	1	U	1.	U	1	U	1	U	1.	U	1.	U	1.	U
Trans-1,3-Dichloropropene	UG/L	U	1.	U	1	U	1.	U	1	U	1.	U	1.	U	1.	U
Trichloroethene	UG/L	U	1.	U	1	U	1.	U	1.	U	1.	U	1	U	1.	U
Vinyl chloride	UG/L	U	1.	U	1.	U	1.	U	1	U	1.	U	1.	U	1.	U
SEMI-VOLATILES																
1,2-Dichlorobenzene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
1,3-Dichlorobenzene	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
1,4-Dichlorobenzene	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
2,4,5-Trichlorophenol	UG/L	U	2.6	U	2.7	U	2.6	U	2.5	U	2.7	U	2.7	U	2.6	U
2,4,6-Trichlorophenol	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2,4-Dichlorophenol	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
2,4-Dimethylphenol	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2,4-Dinitrophenol	UG/L	U	2.6	UJ	2.7	UJ	2.6	U	2.5	U	2.7	U	2.7	U	2.6	U
2,4-Dinitrotoluene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2,6-Dinitrotoluene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2-Chloronaphthalene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2-Chlorophenol	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2-Methylnaphthalene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2-Methylphenol	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
2-Nitroaniline	UG/L	UJ	2.6	U	2.7	UJ	2.6	U	2.5	U	2.7	U	2.7	U	2.6	U
2-Nitrophenol	UG/L	U	1.1	UJ	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
3,3'-Dichlorobenzidine	UG/L	UJ	1.1	UJ	1.1	UJ	1.	U	1.	U	1.1	U	1.1	U	1.	U
3-Nitroaniline	UG/L	UJ	2.6	UJ	2.7	UJ	2.6	UJ	2.5	UJ	2.7	UJ	2.7	UJ	2.6	UJ

Note 1. Reextracted Results Used for PCBs/Pesticides

SURFACE [illegible]R DATA
SEAD-63

	STUDY ID:		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:		67669		67669		67669		67669		67669		67669		67669	
	LOC ID:		SWSD63-7		SWSD63-11		SWSD63-9		SWSD63-6		SWSD63-12		SWSD63-16		SWSD63-17	
	SAMP_ID:		63001		63002		63003		63004		63005		63006		63007	
	FIELD QC CODE:		SA		SA		SA		SA		SA		SA		SA	
	SAMP. DEPTH TOP:		0		0		0		0		0		0		0	
	SAMP. DEPTH BOT:		0.1		0.1		0.1		0.1		0.1		0.1		0.1	
	MATRIX:		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER	
	SAMP. DATE:		4-Dec-97		5-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
4,6 Dinitro-2 methylphenol	UG/L	U	2.6	U	2.7	U	2.6	U	2.5	U	2.7	U	2.7	U	2.6	U
4 Bromophenyl phenyl ether	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
4-Chloro-3 methylphenol	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
4-Chloroaniline	UG/L	UJ	1.1	UJ	1.1	UJ	1	UJ	1	UJ	1.1	UJ	1.1	UJ	1.	UJ
4 Chlorophenyl phenyl ether	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
4-Methylphenol	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	.22	J	1.1	U	1.	U
Acenaphthene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Acenaphthylene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Anthracene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1	U
Benzo(a)anthracene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Benzo(a)pyrene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Benzo(b)fluoranthene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Benzo(ghi)perylene	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
Benzo(k)fluoranthene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Bis(2 Chloroethoxy)methane	UG/L	U	1.1	U	1.1	U	1	U	1.	U	1.1	U	1.1	U	1.	U
Bis(2-Chloroethyl)ether	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
Bis(2-Chloroisopropyl)ether	UG/L	U	1.1	U	1.1	U	1	U	1	U	1.1	U	1.1	U	1.	U
Bis(2-Ethylhexyl)phthalate	UG/L	U	1.1	JU	1.1	U	1.	U	1	U	1.1	UJ	1.1	U	1.	U
Butylbenzylphthalate	UG/L	J	.13	J	1.1	U	.12	J	1.	U	.23	J	1.1	U	1.	U
Carbazole	UG/L	UJ	1.1	UJ	1.1	UJ	1.	UJ	1.	UJ	1.1	UJ	1.1	UJ	1.	UJ
Chrysene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Di-n-butylphthalate	UG/L	J	.059	J	.059	J	1.	U	1	U	1.1	U	1.1	U	1.	U
Di-n-octylphthalate	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Dibenz(a,h)anthracene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Dibenzofuran	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Diethyl phthalate	UG/L	J	.29	J	1.1	U	1.	U	1.	U	.13	J	.071	J	.074	J
Dimethylphthalate	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
Fluoranthene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Fluorene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Hexachlorobenzene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Hexachlorobutadiene	UG/L	U	1.1	U	1.1	U	1	UJ	1.	UJ	1.1	UJ	1.1	UJ	1.	UJ
Hexachlorocyclopentadiene	UG/L	U	1.1	U	1.1	U	1.	UJ	1.	UJ	1.1	UJ	1.1	UJ	1.	UJ
Hexachloroethane	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Indeno(1,2,3-cd)pyrene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Isophorone	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
N-Nitrosodiphenylamine	UG/L	U	1.1	U	1.1	U	1.	U	1	U	1.1	U	1.1	U	1.	U
N-Nitrosodipropylamine	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Naphthalene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Nitrobenzene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Pentachlorophenol	UG/L	U	2.6	UJ	2.7	U	2.6	U	2.5	U	2.7	U	2.7	U	2.6	U
Phenanthrene	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Phenol	UG/L	U	1.1	U	1.1	U	1.	U	1.	U	1.1	U	1.1	U	1.	U
Pyrene	UG/L	U	1.1	U	1.1	U	.005	U	.005	U	.011	U	1.1	U	.011	U
PESTICIDES/PCBs																
4,4'-DDD	UG/L	U	.011	U	.012	U	.01	U	.01	U	.011	U	.011	U	.011	U
4,4'-DDE	UG/L	U	.01	U	.01	U	.01	U	.01	U	.011	U	.011	U	.011	U
4,4'-DDT	UG/L	U	.01	U	.01	JU	.01	U	.01	U	.011	U	.011	U	.011	U
Aldrin	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Alpha-BHC	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Alpha-Chlordane	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Aroclor-1016	UG/L	U	.1	U	.1	U	.1	U	.1	U	.11	U	.11	U	.11	U
Aroclor-1221	UG/L	U	.21	U	.2	U	.2	U	.2	U	.21	U	.21	U	.21	U
Aroclor-1232	UG/L	U	.1	U	.1	U	.1	U	.1	U	.11	U	.11	U	.11	U
Aroclor-1242	UG/L	U	.1	U	.1	U	.1	U	.1	U	.11	U	.11	U	.11	U
Aroclor-1248	UG/L	U	.1	U	.1	U	.1	U	.1	U	.11	U	.11	U	.11	U
Aroclor-1254	UG/L	U	.1	U	.1	U	.1	U	.1	U	.11	U	.11	U	.11	U
Aroclor-1260	UG/L	U	.11	U	1.8	U	.1	U	.1	U	.064	U	.11	U	.11	U
Beta-BHC	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Delta-BHC	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Dieldrin	UG/L	U	.01	U	.01	U	.01	U	.01	U	.011	U	.011	U	.011	U

Note 1. Reextracted Results Used for PCBs/Pesticides

TABLE D-8
SURFACE WATER DATA
SEAD-63

	STUDY ID:		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:		67669		67669		67669		67669		67669		67669		67669	
	LOC ID:		SWSD63-7		SWSD63-11		SWSD63-9		SWSD63-8		SWSD63-12		SWSD63-16		SWSD63-17	
	SAMP_ID:		63001		63002		63003		63004		63005		63006		63007	
	FIELD QC CODE:		SA		SA		SA		SA		SA		SA		SA	
	SAMP. DEPTH TOP:		0		0		0		0		0		0		0	
	SAMP. DEPTH BOT:		0.1		0.1		0.1		0.1		0.1		0.1		0.1	
	MATRIX:		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER		SURFACE WATER	
	SAMP. DATE:		4-Dec-97		9-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q	VALUE	Q
Endosulfan I	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Endosulfan II	UG/L	U	.01	U	.01	U	.01	U	.01	U	.011	U	.011	U	.011	U
Endosulfan sulfate	UG/L	U	.011	J	.01	U	.01	U	.01	U	.011	U	.011	U	.011	U
Endrin aldehyde	UG/L	U	.011	U	.01	U	.01	U	.01	U	.011	U	.011	U	.011	U
Endrin ketone	UG/L	U	.02		.01	U	.01	U	.01	U	.011	U	.011	U	.011	U
Gamma-BHC/Lindane	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Gamma-Chlordane	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Heptachlor	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Heptachlor epoxide	UG/L	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U	.005	U
Hexachlorobenzene	UG/L	U	.01	U	.01	U	.01	U	.01	U	.011	U	.011	U	.011	U
Methoxychlor	UG/L	U	.052	U	.05	U	.051	U	.051	U	.053	U	.053	U	.053	U
Toxaphene	UG/L	U	.52	U	.5	U	.51	U	.51	U	.53	U	.53	U	.53	U
METALS																
Aluminum	UG/L	J	295.		12.3	U	141.	J	41.7	J	98.7	J	30.1	J	12.3	U
Antimony	UG/L	U	3.5	U	3.5	U	3.5	U	3.5	U	3.5	U	3.6	U	3.5	U
Arsenic	UG/L	U	3.8	U	3.8	U	3.8	U	3.8	U	3.8	U	3.8	U	3.8	U
Barium	UG/L	J	19.	J	15.2	J	19.4	J	20.5	J	42.1	J	25.6	J	20.5	J
Beryllium	UG/L	U	.1	U	.13	J	.11	J	1	U	.1	U	.1	U	.17	J
Cadmium	UG/L	U	.3	U	.3	U	.3	U	.3	U	.3	U	.52	J	.3	U
Calcium	UG/L		26,500.		58,900.		46,200.		37,200		57,100.		84,200.		129,000.	
Chromium	UG/L	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Cobalt	UG/L	U	1.7	U	1.7	U	1.7	U	1.7	U	2.2	J	1.7	U	1.7	U
Copper	UG/L	U	2.3	U	2.3	U	2.3	U	2.3	U	2.4	J	2.3	U	2.3	U
Cyanide	UG/L	U	5.3	U	5.	U	5.1	U	5.	U	5.	U	5.	U	5.	U
Iron	UG/L		331.		25.6	U	247.		136.		702.		58.1	J	25.6	U
Lead	UG/L	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U
Magnesium	UG/L		5,560.		9,860.		7,610		7,540.		9,410.		8,750.		18,300.	
Manganese	UG/L		650.		.8	J	43.6		655.		1,930.		126.		5.6	J
Mercury	UG/L	U	.1	U	.1	U	.1	U	.1	U	.1	U	.1	U	.1	U
Nickel	UG/L	J	2.3	U	2.3	U	2.3	U	2.3	U	3.	J	2.3	U	2.8	J
Potassium	UG/L	J	5,640.		2,700.	J	2,740	J	5,990.		6,620.		4,150.	J	4,170.	J
Selenium	UG/L	U	4.7	U	4.7	U	4.7	U	4.7	U	4.7	U	4.7	U	4.7	U
Silver	UG/L	U	2.1	U	2.1	U	2.1	U	2.1	U	2.1	U	2.1	U	2.1	U
Sodium	UG/L	J	2,230.	J	11,400.		15,800.		2,860	J	2,660.	J	1,120.	J	8,140.	
Thallium	UG/L	U	6.3	U	6.3	U	6.3	U	6.3	U	6.3	U	6.3	U	6.3	U
Vanadium	UG/L	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
Zinc	UG/L	J	16.2	J	5.1	J	4.7	J	5.	J	14.9	J	6.7	J	4.9	J
Note 1: Reextracted Results Used for PCBs/Pesticides																

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67669		67669		67669	
	LOC ID:	SWSD63-18		SWSD63-19		SWSD63-20	
	SAMP_ID:	63008		63009		63010	
	FIELD QC CODE:	SA		SA		SA	
	SAMP. DEPTH TOP:	0		0		0	
	SAMP. DEPTH BOT:	0.1		0.1		0.1	
	MATRIX:	SURFACE WATER		SURFACE WATER		SURFACE WATER	
	SAMP. DATE:	11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q
VOLATILES							
1,1,1-Trichloroethane	UG/L	1.	U	1	U	1.	U
1,1,2,2-Tetrachloroethane	UG/L	1.	U	1.	U	1	U
1,1,2-Trichloroethane	UG/L	1.	U	1.	U	1.	U
1,1-Dichloroethane	UG/L	1	U	1	U	1	U
1,1-Dichloroethene	UG/L	1	U	1.	U	1	U
1,2-Dibromo-3-chloropropane	UG/L	1.	U	1.	U	1	U
1,2-Dibromoethane	UG/L	1.	U	1.	U	1	U
1,2-Dichlorobenzene	UG/L	1.	U	1.	U	1	U
1,2-Dichloroethane	UG/L	1	U	1.	U	1	U
1,2-Dichloropropane	UG/L	1.	U	1.	U	1	U
1,3-Dichlorobenzene	UG/L	1.	U	1.	U	1.	U
1,4-Dichlorobenzene	UG/L	1.	U	1.	U	1	U
Acetone	UG/L	5.	U	5	U	5	U
Benzene	UG/L	1	U	1	U	1.	U
Bromochloromethane	UG/L	1.	U	1.	U	1.	U
Bromodichloromethane	UG/L	1.	U	1.	U	1	U
Bromoform	UG/L	1.	U	1	U	1	U
Carbon disulfide	UG/L	1.	U	1	U	1	U
Carbon tetrachloride	UG/L	1.	U	1.	U	1.	U
Chlorobenzene	UG/L	1.	U	1	U	1.	U
Chlorodibromomethane	UG/L	1.	U	1.	U	1.	U
Chloroethane	UG/L	1.	U	1.	U	1.	U
Chloroform	UG/L	1.	U	1	U	1	U
Cis-1,2-Dichloroethene	UG/L	1.	U	1	U	1.	U
Cis-1,3-Dichloropropene	UG/L	1.	U	1.	U	1.	U
Ethyl benzene	UG/L	1.	U	1.	U	1	U
Methyl bromide	UG/L	1.	U	1.	U	1.	U
Methyl butyl ketone	UG/L	5.	U	5.	U	5	U
Methyl chloride	UG/L	1.	U	1.	U	1.	U
Methyl ethyl ketone	UG/L	5.	U	5.	U	5.	U
Methyl isobutyl ketone	UG/L	5.	U	5	U	5	U
Methylene chloride	UG/L	2.	U	2.	U	2	U
Styrene	UG/L	1.	U	1.	U	1.	U
Tetrachloroethene	UG/L	1.	U	1.	U	1	U
Toluene	UG/L	1.		1.	U	1.	U
Total Xylenes	UG/L	1.	U	1.	U	1.	U
Trans-1,2-Dichloroethene	UG/L	1.	U	1	U	1	U
Trans-1,3-Dichloropropene	UG/L	1.	U	1.	U	1	U
Trichloroethene	UG/L	1.	U	1	U	1	U
Vinyl chloride	UG/L	1.	U	1	U	1	U
SEMI-VOLATILES							
1,2-Dichlorobenzene	UG/L	1.1	U	1	U	1.1	U
1,3-Dichlorobenzene	UG/L	1.1	U	1	U	1.1	U
1,4-Dichlorobenzene	UG/L	1.1	U	1.	U	1.1	U
2,4,5-Trichlorophenol	UG/L	2.8	U	2.6	U	2.7	U
2,4,6-Trichlorophenol	UG/L	1.1	U	1.	U	1.1	U
2,4-Dichlorophenol	UG/L	1.1	U	1.	U	1.1	U
2,4-Dimethylphenol	UG/L	1.1	U	1.	U	1.1	U
2,4-Dinitrophenol	UG/L	2.8	U	2.6	U	2.7	U
2,4-Dinitrotoluene	UG/L	1.1	U	1.	U	1.1	U
2,6-Dinitrotoluene	UG/L	1.1	U	1.	U	1.1	U
2-Chloronaphthalene	UG/L	1.1	U	1.	U	1.1	U
2-Chlorophenol	UG/L	1.1	U	1.	U	1.1	U
2-Methylnaphthalene	UG/L	1.1	U	1.	U	1.1	U
2-Methylphenol	UG/L	1.1	U	1.	U	1.1	U
2-Nitroaniline	UG/L	2.8	U	2.6	U	2.7	U
2-Nitrophenol	UG/L	1.1	U	1	U	1.1	U
3,3'-Dichlorobenzidine	UG/L	1.1	U	1.	U	1.1	U
3-Nitroaniline	UG/L	2.8	UJ	2.6	UJ	2.7	UJ

Note 1. Reextracted Results Used for PCBs/Pesticides

TABLE D-8
SURFACE WATER DATA
SEAD-63

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67669		67669		67669	
	LOC ID:	SWSD63-18		SWSD63-19		SWSD63-20	
	SAMP_ID:	63008		63009		63010	
	FIELD QC CODE:	SA		SA		SA	
	SAMP. DEPTH TOP:	0		0		0	
	SAMP. DEPTH BOT:	0.1		0.1		0.1	
	MATRIX:	SURFACE WATER		SURFACE WATER		SURFACE WATER	
	SAMP. DATE:	11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	VALUE	Q	VALUE	Q	VALUE	Q
4,6-Dinitro-2-methylphenol	UG/L	2.8	U	2.6	U	2.7	U
4-Bromophenyl phenyl ether	UG/L	1.1	U	1.	U	1.1	U
4-Chloro-3-methylphenol	UG/L	1.1	U	1.	U	1.1	U
4-Chloroaniline	UG/L	1.1	UJ	1.	UJ	1.1	UJ
4-Chlorophenyl phenyl ether	UG/L	1.1	U	1.	U	1.1	U
4-Methylphenol	UG/L	1.1	U	1.	U	1.1	U
Acenaphthene	UG/L	1.1	U	1.	U	1.1	U
Acenaphthylene	UG/L	1.1	U	1.	U	1.1	U
Anthracene	UG/L	1.1	U	1.	U	1.1	U
Benzo(a)anthracene	UG/L	1.1	U	1.	U	1.1	U
Benzo(a)pyrene	UG/L	1.1	U	1.	U	1.1	U
Benzo(b)fluoranthene	UG/L	1.1	U	1.	U	1.1	U
Benzo(ghi)perylene	UG/L	1.1	U	1.	U	1.1	U
Benzo(k)fluoranthene	UG/L	1.1	U	1.	U	1.1	U
Bis(2-Chloroethoxy)methane	UG/L	1.1	U	1.	U	1.1	U
Bis(2-Chloroethyl)ether	UG/L	1.1	U	1.	U	1.1	U
Bis(2-Chloroisopropyl)ether	UG/L	1.1	U	1.	U	1.1	U
Bis(2-Ethylhexyl)phthalate	UG/L	1.1	U	1.	UJ	1.1	U
Butylbenzylphthalate	UG/L	1.1	U	.092	J	1.1	U
Carbazole	UG/L	1.1	UJ	1	UJ	1.1	UJ
Chrysene	UG/L	1.1	U	1.	U	1.1	U
Di-n-butylphthalate	UG/L	.1	J	1.	U	1.1	U
Di-n-octylphthalate	UG/L	1.1	U	1.	U	1.1	U
Dibenz(a,h)anthracene	UG/L	1.1	U	1.	U	1.1	U
Dibenzofuran	UG/L	1.1	U	1.	U	1.1	U
Diethyl phthalate	UG/L	1.1	U	1.	U	1.1	U
Dimethylphthalate	UG/L	1.1	U	1.	U	1.1	U
Fluoranthene	UG/L	.092	J	1.	U	1.1	U
Fluorene	UG/L	1.1	U	1.	U	1.1	U
Hexachlorobenzene	UG/L	1.1	U	1.	U	1.1	U
Hexachlorobutadiene	UG/L	1.1	UJ	1.	UJ	1.1	UJ
Hexachlorocyclopentadiene	UG/L	1.1	UJ	1.	UJ	1.1	UJ
Hexachloroethane	UG/L	1.1	U	1.	U	1.1	U
Indeno(1,2,3-cd)pyrene	UG/L	1.1	U	1.	U	1.1	U
Isophorone	UG/L	1.1	U	1.	U	1.1	U
N-Nitrosodiphenylamine	UG/L	1.1	U	1.	U	1.1	U
N-Nitrosodipropylamine	UG/L	1.1	U	1.	U	1.1	U
Naphthalene	UG/L	1.1	U	1.	U	1.1	U
Nitrobenzene	UG/L	1.1	U	1	U	1.1	U
Pentachlorophenol	UG/L	2.8	U	2.6	U	2.7	U
Phenanthrene	UG/L	.057	J	1.	U	1.1	U
Phenol	UG/L	1.1	U	1.	U	1.1	U
Pyrene	UG/L	.011	UJ	.005	U	.011	U
PESTICIDES/PCBs							
4,4'-DDD	UG/L	.011	U	01	U	.011	U
4,4'-DDE	UG/L	.011	U	.01	U	.011	U
4,4'-DDT	UG/L	.011	U	01	U	.011	U
Aldrin	UG/L	.005	U	.005	U	.005	U
Alpha-BHC	UG/L	.005	U	.005	U	.005	U
Alpha-Chlordane	UG/L	.005	U	.005	U	.005	U
Aroclor-1016	UG/L	.11	U	.1	U	.11	U
Aroclor-1221	UG/L	.21	U	.2	U	.21	U
Aroclor-1232	UG/L	.11	U	.1	U	.11	U
Aroclor-1242	UG/L	.11	U	.1	U	.11	U
Aroclor-1248	UG/L	.11	U	.1	U	.11	U
Aroclor-1254	UG/L	.11	U	.1	U	.11	U
Aroclor-1260	UG/L	.11	U	.1	U	.11	U
Beta-BHC	UG/L	.005	U	.005	U	.005	U
Delta-BHC	UG/L	.005	U	005	U	.005	U
Dieldrin	UG/L	.011	U	.01	U	011	U

Note 1. Reextracted Results Used for PCBs/Pesticides

	STUDY ID:	RI Phase 1 Step 1		RI Phase 1 Step 1		RI Phase 1 Step 1	
	SDG:	67669		67669		67669	
	LOC ID:	SWSD63-18		SWSD63-19		SWSD63-20	
	SAMP_ID	63008		63009		63010	
	FIELD QC CODE:	SA		SA		SA	
	SAMP. DEPTH TOP:	0		0		0	
	SAMP. DEPTH BOT:	0 1		0 1		0 1	
	MATRIX	SURFACE WATER		SURFACE WATER		SURFACE WATER	
	SAMP. DATE	11-Dec-97		11-Dec-97		11-Dec-97	
PARAMETER	UNIT	- VALUE	Q	VALUE	Q	VALUE	Q
Endosulfan I	UG/L	.005	U	005	U	005	U
Endosulfan II	UG/L	.011	U	01	U	011	U
Endosulfan sulfate	UG/L	.011	U	01	U	011	U
Endrin aldehyde	UG/L	011	U	.01	U	011	U
Endrin ketone	UG/L	011	U	.01	U	.011	U
Gamma BHC/Lindane	UG/L	005	U	005	U	005	U
Gamma Chlordane	UG/L	.005	U	005	U	.005	U
Heptachlor	UG/L	005	U	005	U	005	U
Heptachlor epoxide	UG/L	.005	U	005	U	005	U
Hexachlorobenzene	UG/L	.011	U	.01	U	011	U
Methoxychlor	UG/L	.053	U	051	U	.053	U
Toxaphene	UG/L	.53	U	.51	U	.53	U
METALS							
Aluminum	UG/L	1,020.		12 3	U	30	J
Antimony	UG/L	3.5	U	3 5	U	3 5	U
Arsenic	UG/L	3 6	U	3 6	U	3 6	U
Barium	UG/L	36 8	J	31 3	J	25 5	J
Beryllium	UG/L	.16	J	.19	J	.18	J
Cadmium	UG/L	.3	U	.3	U	.3	U
Calcium	UG/L	83,100.		134,000		86,400.	
Chromium	UG/L	1.2	J	1.1	U	1.1	U
Cobalt	UG/L	1.7	U	1.7	U	1.7	U
Copper	UG/L	2.5	J	2 3	U	2.5	J
Cyanide	UG/L	5	U	5.1	U	5	U
Iron	UG/L	1,360		25 6	U	59 5	J
Lead	UG/L	1.8	U	1.8	U	1.8	U
Magnesium	UG/L	10,200.		18,900.		12,200	
Manganese	UG/L	95.9		6 1	J	2 7	J
Mercury	UG/L	.1	U	.1	U	1	U
Nickel	UG/L	2.9	J	2.3	U	2.5	J
Potassium	UG/L	11,600		4,450.	J	5,010	
Selenium	UG/L	4.7	U	4 7	U	4 7	U
Silver	UG/L	2 1	U	2.1	U	2.1	U
Sodium	UG/L	10,400		8,660.		23,800	
Thallium	UG/L	6 3	U	6 3	U	6 3	U
Vanadium	UG/L	1.6	U	1 6	U	1 6	U
Zinc	UG/L	13.1	J	4.1	J	5.1	J
Note 1. Reextracted Results Used for PCBs/Pesticides							

APPENDIX E

RESRAD INPUTS AND OUTPUTS

RESRAD INPUTS

Table E-1
Input Parameters for RESRAD
Non-Scenario Specific

Parameter	Value Assigned	Rationale
Cover depth (m)	0	Assume surface contamination - worst case for time=0 years
Density of cover material (g/cm**3)	not used	
Cover depth erosion rate (m/yr)	not used	
Density of contaminated zone (g/cm**3)	1.5	Default Value
Contaminated zone erosion rate (m/yr)	6 x 10^{-5}	(1) Appendix A - Assume 2% slope, farm family
Contaminated zone total porosity	0.37	(2)
Contaminated zone effective porosity	0.175	(3)
Contaminated zone hydraulic conductivity (m/yr)	208 (6.61 x 10^{-4} cm/yr)	(4) p. 3-40
Contaminated zone b parameter	7.75	(1) App. E, Silty Clay Loam
Average annual wind speed (m/sec)	3 (7 mi/hr)	Estimated using wind rose for Syracuse NY (Fig 2-7)
Humidity in air (g/m**3)	6.6	(1) App. L, Fig. L-1
Evapotranspiration coefficient	0.7	(3) (see calcs attached)
Precipitation (m/yr)	0.75 (29.4 in/yr)	(4) p. 1-16
Irrigation (m/yr)	0	No irrigation
Irrigation mode	overhead	
Runoff coefficient	0.2	(3)
Watershed area for nearby stream or pond (m**2)	13,000,000	(4) Fig 1-9 attached
Accuracy for water/soil computations	0.001	Default value
Density of saturated zone (g/cm**3)	1.5	Default value
Saturated zone total porosity	0.37	(2)
Saturated zone effective porosity	0.175	(3)
Saturated zone hydraulic conductivity (m/yr)	208	(4) p. 3-40
Saturated zone hydraulic gradient	0.012	(4) p. 3-41
Saturated zone b parameter	Not Applicable	
Water table drop rate (m/yr)	0	Assumption
Well pump intake depth (m below water table)	3	(4) p. 1-14

Table E-1 (con't)
Input Parameters for RESRAD

Parameter	Value Assigned	Rationale
Model: Nondispersion (ND) or Mass-Balance (MB)	ND	(1) App. E, p. 207
Well pumping rate (m**3/yr)	50 (100ml/min)	(5)
Number of unsaturated zone strata	1	
Unsat. zone 1, thickness (m)	1	(6)
Unsat. zone 1, soil density (g/cm**3)	1.5	Default
Unsat. zone 1, total porosity	0.37	(2)
Unsat. zone 1, effective porosity	0.175	(3)
Unsat. zone 1, soil-specific b parameter	7.75	(1) App. E, silty clay loam
Unsat. zone 1, hydraulic conductivity (m/yr)	208	(4) p. 3-40

Sources:

(1) Argonne National Laboratory, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0,, September 1993.

(2) U.S. Army Environmental Hygiene Agency (USAEHA), Phase 4 Evaluation of the Open Burning/Open Detonation Grounds. Investigation of Soil Contamination, Hazardous Waste Study No. 37-26-0479-85, 1984.

(3) Parsons Engineering Science, Final Groundwater Modeling Report at the Ash Landfill Site, June 1996.

(4) Parsons Engineering Science, Remedial Investigation Report at the Open Burning Grounds, September 1994.

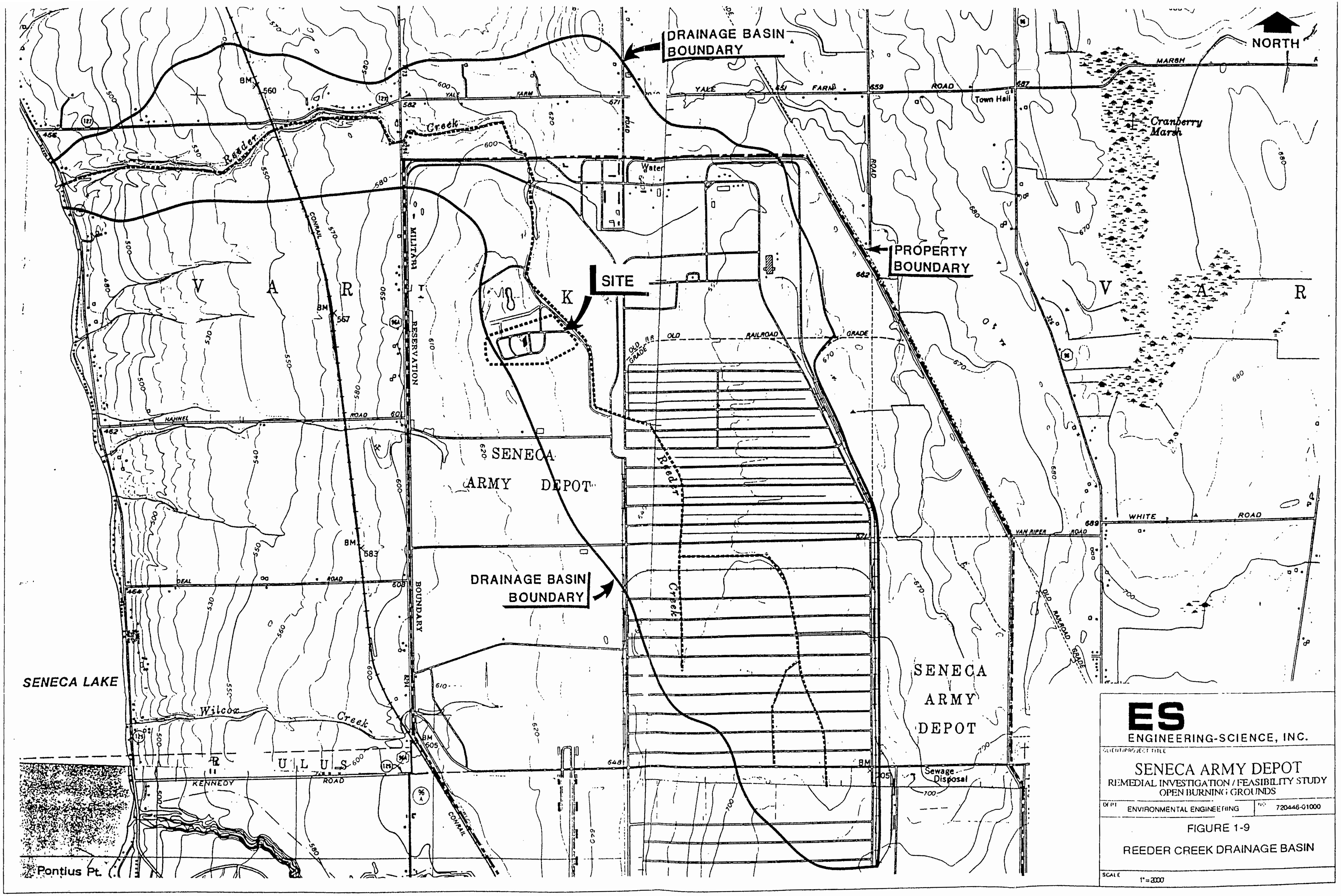
(5) Based on field experience that 100 ml/min is a sustainable rate for extraction of groundwater from upper aquifer during well purging in preparation for groundwater sampling.

(6) Parsons Engineering Science, Expanded Site Inspection Seven Low Priority AOCs – SEADs 60, 62, 63, 64 (A, B, C, D) 67, 70, and 71, April 1996.

TABLE C-7. LABORATORY ANALYSIS OF SOILS

Bore Hole No. Depth of Sample Sample Type	1 3 Bag	2 4 ST	2 7 Bag	4 4 ST	8 3 Bag
Grain Size Analysis					
% Passing No. 4 (sieve)	91.1	99.3	97.3	100.0	98.7
% Passing No. 10 (sieve)	78.8	98.4	91.4	99.7	96.3
% Passing No. 20 (sieve)	63.3	97.8	88.1	99.4	94.5
% Passing No. 40 (sieve)	50.6	91.8	79.2	96.0	82.6
% Passing No. 100 (sieve)	50.6	91.8	79.2	96.0	82.6
% Passing No. 200 (sieve)	46.8	84.7	76.6	92.7	71.8
Atterberg Limits					
Liquid Limit W_L	36.2	41.9	34.6	44.0	37.1
Plastic Limit W_P	30.1	24.2	20.7	30.9	23.4
Plastic Index I_P	6.1	17.7	13.9	13.1	13.7
Unified Soil Classification	SM	CL	CL	ML	CL
Permeability Cm/sc (k)					
Proctor Density - compaction mold	3.01×10^{-7}	1.41×10^{-3}	4.22×10^{-7}	6.88×10^{-3}	3.30×10^{-7}
Void Ratio (k)	0.588	0.685	0.620	0.793	0.515
% Saturation (k)	101.05	112.10	98.69	110.25	100.64
% Porosity (k)	37.0	36.9	34.2	44.2	34.0
Dry Density (k)	1.70	1.70	1.78	1.51	1.78
% Moisture Content (k)	22.0	24.3	19.0	32.4	19.2
Specific Gravity *assumed	2.7*	2.7*	2.7*	2.7*	2.7*

Hazardous Waste Study No. 37-26-0479-85, SEAD, NY, 13-19 Aug 84



ES

ENGINEERING-SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT ENVIRONMENTAL ENGINEERING NO. 720446-01000

FIGURE 1-9

REEDER CREEK DRAINAGE BASIN

SCALE 1" = 2000

TABLE C-7. LABORATORY ANALYSIS OF SOILS

Bore Hole No.	1	2	2	4	8
Depth of Sample	3	4	7	4	3
Sample Type	Bag	ST	Bag	ST	Bag
Grain Size Analysis					
% Passing No. 4 (sieve)	91.1	99.3	97.3	100.0	98.7
% Passing No. 10 (sieve)	78.8	98.4	91.4	99.7	96.3
% Passing No. 20 (sieve)	63.3	97.8	88.1	99.4	94.5
% Passing No. 40 (sieve)	60.6	91.8	79.2	96.0	82.6
% Passing No. 100 (sieve)	60.6	91.8	79.2	96.0	82.6
% Passing No. 200 (sieve)	46.8	84.7	76.6	92.7	71.8
Atterberg Limits					
Liquid Limit W_L	36.2	41.9	34.6	44.0	37.1
Plastic Limit W_P	30.1	24.2	20.7	30.9	23.4
Plastic Index I_P	6.1	17.7	13.9	13.1	13.7
Unified Soil Classification	SM	CL	CL	ML	CL
Permeability Cm/sc (k)					
Proctor Density - compaction mold	3.01×10^{-7}	1.41×10^{-3}	4.22×10^{-7}	6.88×10^{-3}	3.30×10^{-7}
Void Ratio (k)	0.588	0.685	0.520	0.793	0.515
% Saturation (k)	101.05	112.10	98.69	110.26	100.64
% Porosity (k)	37.0	36.9	34.2	44.2	34.0
Dry Density (k)	1.70	1.70	1.78	1.51	1.78
% Moisture Content (k)	22.0	24.3	19.0	32.4	19.2
Specific Gravity *assumed	2.7*	2.7*	2.7*	2.7*	2.7*

RESRAD OUTPUT FOR CONSTRUCTION WORKER – SEDIMENT SUPPORT FOR COMPLIANCE WITH NYSDEC TAGM

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

```
                          Dose Conversion Factor (and Related) Parameter Summary
                                           File: DOSFAC.BIN

      |                                                       |  Current   |            |  Parameter
Menu  |                      Parameter                        |   Value    |  Default   |    Name
------+-------------------------------------------------------+------------+------------+--------------
B-1   | Dose conversion factors for inhalation, mrem/pCi:     |            |            |
B-1   | Cs-137+D                                              | 3.190E-05  | 3.190E-05  | DCF2( 1)
B-1   | Pb-210+D                                              | 2.320E-02  | 2.320E-02  | DCF2( 2)
B-1   | Ra-226+D                                              | 8.600E-03  | 8.600E-03  | DCF2( 3)
B-1   | Th-230                                                | 3.260E-01  | 3.260E-01  | DCF2( 4)
B-1   | U-234                                                 | 1.320E-01  | 1.320E-01  | DCF2( 5)
B-1   | U-238+D                                               | 1.180E-01  | 1.180E-01  | DCF2( 6)
      |                                                       |            |            |
D-1   | Dose conversion factors for ingestion, mrem/pCi:      |            |            |
D-1   | Cs-137+D                                              | 5.000E-05  | 5.000E-05  | DCF3( 1)
D-1   | Pb-210+D                                              | 7.270E-03  | 7.270E-03  | DCF3( 2)
D-1   | Ra-226+D                                              | 1.330E-03  | 1.330E-03  | DCF3( 3)
D-1   | Th-230                                                | 5.480E-04  | 5.480E-04  | DCF3( 4)
D-1   | U-234                                                 | 2.830E-04  | 2.830E-04  | DCF3( 5)
D-1   | U-238+D                                               | 2.690E-04  | 2.690E-04  | DCF3( 6)
      |                                                       |            |            |
D-34  | Food transfer factors:                                |            |            |
D-34  | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02  | 4.000E-02  | RTF( 1,1)
D-34  | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02  | 3.000E-02  | RTF( 1,2)
D-34  | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 8.000E-03  | 8.000E-03  | RTF( 1,3)
D-34  |                                                       |            |            |
D-34  | Pb-210+D , plant/soil concentration ratio, dimensionless | 1.000E-02  | 1.000E-02  | RTF( 2,1)
D-34  | Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04  | 8.000E-04  | RTF( 2,2)
D-34  | Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 3.000E-04  | 3.000E-04  | RTF( 2,3)
D-34  |                                                       |            |            |
D-34  | Ra-226+D , plant/soil concentration ratio, dimensionless | 4.000E-02  | 4.000E-02  | RTF( 3,1)
D-34  | Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03  | 1.000E-03  | RTF( 3,2)
D-34  | Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03  | 1.000E-03  | RTF( 3,3)
D-34  |                                                       |            |            |
D-34  | Th-230   , plant/soil concentration ratio, dimensionless | 1.000E-03  | 1.000E-03  | RTF( 4,1)
D-34  | Th-230   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04  | 1.000E-04  | RTF( 4,2)
D-34  | Th-230   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06  | 5.000E-06  | RTF( 4,3)
D-34  |                                                       |            |            |
D-34  | U-234    , plant/soil concentration ratio, dimensionless | 2.500E-03  | 2.500E-03  | RTF( 5,1)
D-34  | U-234    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04  | 3.400E-04  | RTF( 5,2)
D-34  | U-234    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04  | 6.000E-04  | RTF( 5,3)
D-34  |                                                       |            |            |
D-34  | U-238+D  , plant/soil concentration ratio, dimensionless | 2.500E-03  | 2.500E-03  | RTF( 6,1)
D-34  | U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04  | 3.400E-04  | RTF( 6,2)
D-34  | U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04  | 6.000E-04  | RTF( 6,3)
      |                                                       |            |            |
D-5   | Bioaccumulation factors, fresh water, L/kg:           |            |            |
D-5   | Cs-137+D , fish                                       | 2.000E+03  | 2.000E+03  | BIOFAC( 1,1)
D-5   | Cs-137+D , crustacea and mollusks                     | 1.000E+02  | 1.000E+02  | BIOFAC( 1,2)
D-5   |                                                       |            |            |
D-5   | Pb-210+D , fish                                       | 3.000E+02  | 3.000E+02  | BIOFAC( 2,1)
D-5   | Pb-210+D , crustacea and mollusks                     | 1.000E+02  | 1.000E+02  | BIOFAC( 2,2)
D-5   |                                                       |            |            |
D-5   | Ra-226+D , fish                                       | 5.000E+01  | 5.000E+01  | BIOFAC( 3,1)
D-5   | Ra-226+D , crustacea and mollusks                     | 2.500E+02  | 2.500E+02  | BIOFAC( 3,2)
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                    Dose Conversion Factor (and Related) Parameter Summary (continued)
                                          File: DOSFAC.BIN

     |                                                          | Current   |           | Parameter
Menu |                       Parameter                          |  Value    |  Default  |   Name
-----+----------------------------------------------------------+-----------+-----------+-------------
D-5  | Th-230    , fish                                         | 1.000E+02 | 1.000E+02 | BIOFAC( 4,1)
D-5  | Th-230    , crustacea and mollusks                       | 5.000E+02 | 5.000E+02 | BIOFAC( 4,2)
D-5  |                                                          |           |           |
D-5  | U-234     , fish                                         | 1.000E+01 | 1.000E+01 | BIOFAC( 5,1)
D-5  | U-234     , crustacea and mollusks                       | 6.000E+01 | 6.000E+01 | BIOFAC( 5,2)
D-5  |                                                          |           |           |
D-5  | U-238+D   , fish                                         | 1.000E+01 | 1.000E+01 | BIOFAC( 6,1)
D-5  | U-238+D   , crustacea and mollusks                       | 6.000E+01 | 6.000E+01 | BIOFAC( 6,2)
=====+==========================================================+===========+===========+=============
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                                                Site-Specific Parameter Summary

     |                                                             |    User    |            |        Used by RESRAD              |  Parameter
Menu |                     Parameter                               |    Input   |  Default   | (If different from user input)     |    Name
-----+-------------------------------------------------------------+------------+------------+------------------------------------+--------------
R011 | Area of contaminated zone (m**2)                            | 6.500E+04  | 1.000E+04  |                ---                 | AREA
R011 | Thickness of contaminated zone (m)                          | 1.000E+00  | 2.000E+00  |                ---                 | THICK0
R011 | Length parallel to aquifer flow (m)                         | not used   | 1.000E+02  |                ---                 | LCZPAQ
R011 | Basic radiation dose limit (mrem/yr)                        | 1.000E+01  | 3.000E+01  |                ---                 | BRDL
R011 | Time since placement of material (yr)                       | 0.000E+00  | 0.000E+00  |                ---                 | TI
R011 | Times for calculations (yr)                                 | 1.000E+00  | 1.000E+00  |                ---                 | T( 2)
R011 | Times for calculations (yr)                                 | 5.000E+00  | 3.000E+00  |                ---                 | T( 3)
R011 | Times for calculations (yr)                                 | 1.000E+01  | 1.000E+01  |                ---                 | T( 4)
R011 | Times for calculations (yr)                                 | 2.500E+01  | 3.000E+01  |                ---                 | T( 5)
R011 | Times for calculations (yr)                                 | 4.000E+01  | 1.000E+02  |                ---                 | T( 6)
R011 | Times for calculations (yr)                                 | 5.500E+01  | 3.000E+02  |                ---                 | T( 7)
R011 | Times for calculations (yr)                                 | 7.000E+01  | 1.000E+03  |                ---                 | T( 8)
R011 | Times for calculations (yr)                                 | not used   | 0.000E+00  |                ---                 | T( 9)
R011 | Times for calculations (yr)                                 | not used   | 0.000E+00  |                ---                 | T(10)
     |                                                             |            |            |                                    |
R012 | Initial principal radionuclide (pCi/g):  Cs-137             | 1.500E+00  | 0.000E+00  |                ---                 | S1( 1)
R012 | Initial principal radionuclide (pCi/g):  Pb-210             | 9.100E+00  | 0.000E+00  |                ---                 | S1( 2)
R012 | Initial principal radionuclide (pCi/g):  Th-230             | 2.200E+00  | 0.000E+00  |                ---                 | S1( 4)
R012 | Initial principal radionuclide (pCi/g):  U-234              | 1.300E+00  | 0.000E+00  |                ---                 | S1( 5)
R012 | Initial principal radionuclide (pCi/g):  U-238              | 1.400E+00  | 0.000E+00  |                ---                 | S1( 6)
R012 | Concentration in groundwater   (pCi/L):  Cs-137             | not used   | 0.000E+00  |                ---                 | W1( 1)
R012 | Concentration in groundwater   (pCi/L):  Pb-210             | not used   | 0.000E+00  |                ---                 | W1( 2)
R012 | Concentration in groundwater   (pCi/L):  Th-230             | not used   | 0.000E+00  |                ---                 | W1( 4)
R012 | Concentration in groundwater   (pCi/L):  U-234              | not used   | 0.000E+00  |                ---                 | W1( 5)
R012 | Concentration in groundwater   (pCi/L):  U-238              | not used   | 0.000E+00  |                ---                 | W1( 6)
     |                                                             |            |            |                                    |
R013 | Cover depth (m)                                             | 0.000E+00  | 0.000E+00  |                ---                 | COVER0
R013 | Density of cover material (g/cm**3)                         | not used   | 1.500E+00  |                ---                 | DENSCV
R013 | Cover depth erosion rate (m/yr)                             | not used   | 1.000E-03  |                ---                 | VCV
R013 | Density of contaminated zone (g/cm**3)                      | 1.500E+00  | 1.500E+00  |                ---                 | DENSCZ
R013 | Contaminated zone erosion rate (m/yr)                       | 6.000E-05  | 1.000E-03  |                ---                 | VCZ
R013 | Contaminated zone total porosity                            | 3.700E-01  | 4.000E-01  |                ---                 | TPCZ
R013 | Contaminated zone effective porosity                        | 1.750E-01  | 2.000E-01  |                ---                 | EPCZ
R013 | Contaminated zone hydraulic conductivity (m/yr)             | 2.080E+02  | 1.000E+01  |                ---                 | HCCZ
R013 | Contaminated zone b parameter                               | 7.750E+00  | 5.300E+00  |                ---                 | BCZ
R013 | Average annual wind speed (m/sec)                           | 3.000E+00  | 2.000E+00  |                ---                 | WIND
R013 | Humidity in air (g/m**3)                                    | not used   | 8.000E+00  |                ---                 | HUMID
R013 | Evapotranspiration coefficient                              | 7.100E-01  | 5.000E-01  |                ---                 | EVAPTR
R013 | Precipitation (m/yr)                                        | 7.500E-01  | 1.000E+00  |                ---                 | PRECIP
R013 | Irrigation (m/yr)                                           | 0.000E+00  | 2.000E-01  |                ---                 | RI
R013 | Irrigation mode                                             | overhead   | overhead   |                ---                 | IDITCH
R013 | Runoff coefficient                                          | 2.000E-01  | 2.000E-01  |                ---                 | RUNOFF
R013 | Watershed area for nearby stream or pond (m**2)             | not used   | 1.000E+06  |                ---                 | WAREA
R013 | Accuracy for water/soil computations                        | not used   | 1.000E-03  |                ---                 | EPS
     |                                                             |            |            |                                    |
R014 | Density of saturated zone (g/cm**3)                         | 1.500E+00  | 1.500E+00  |                ---                 | DENSAQ
R014 | Saturated zone total porosity                               | 3.700E-01  | 4.000E-01  |                ---                 | TPSZ
R014 | Saturated zone effective porosity                           | 1.750E-01  | 2.000E-01  |                ---                 | EPSZ
R014 | Saturated zone hydraulic conductivity (m/yr)                | 2.080E+02  | 1.000E+02  |                ---                 | HCSZ
R014 | Saturated zone hydraulic gradient                           | 1.200E-02  | 2.000E-02  |                ---                 | HGWT
```

```
                                Site-Specific Parameter Summary (continued)

      |                                              |    User    |            |           Used by RESRAD            |   Parameter
Menu  |                  Parameter                   |   Input    |  Default   | (If different from user input)      |     Name
------+----------------------------------------------+------------+------------+-------------------------------------+-------------
R014  | Saturated zone b parameter                   | 1.040E+01  | 5.300E+00  |                ---                  | BSZ
R014  | Water table drop rate (m/yr)                 | 0.000E+00  | 1.000E-03  |                ---                  | VWT
R014  | Well pump intake depth (m below water table) | 3.000E+00  | 1.000E+01  |                ---                  | DWIBWT
R014  | Model: Nondispersion (ND) or Mass-Balance (MB)| ND        | ND         |                ---                  | MODEL
R014  | Well pumping rate (m**3/yr)                  | 5.000E+01  | 2.500E+02  |                ---                  | UW
      |                                              |            |            |                                     |
R015  | Number of unsaturated zone strata            | not used   | 1          |                ---                  | NS
R015  | Unsat. zone 1, thickness (m)                 | not used   | 4.000E+00  |                ---                  | H(1)
R015  | Unsat. zone 1, soil density (g/cm**3)        | not used   | 1.500E+00  |                ---                  | DENSUZ(1)
R015  | Unsat. zone 1, total porosity                | not used   | 4.000E-01  |                ---                  | TPUZ(1)
R015  | Unsat. zone 1, effective porosity            | not used   | 2.000E-01  |                ---                  | EPUZ(1)
R015  | Unsat. zone 1, soil-specific b parameter     | not used   | 5.300E+00  |                ---                  | BUZ(1)
R015  | Unsat. zone 1, hydraulic conductivity (m/yr) | not used   | 1.000E+01  |                ---                  | HCUZ(1)
      |                                              |            |            |                                     |
R016  | Distribution coefficients for Cs-137         |            |            |                                     |
R016  |   Contaminated zone (cm**3/g)                | 1.000E+03  | 1.000E+03  |                ---                  | DCNUCC( 1)
R016  |   Unsaturated zone 1 (cm**3/g)               | not used   | 1.000E+03  |                ---                  | DCNUCU( 1,1)
R016  |   Saturated zone (cm**3/g)                   | not used   | 1.000E+03  |                ---                  | DCNUCS( 1)
R016  |   Leach rate (/yr)                           | 0.000E+00  | 0.000E+00  |             1.160E-04               | ALEACH( 1)
R016  |   Solubility constant                        | 0.000E+00  | 0.000E+00  |             not used                | SOLUBK( 1)
      |                                              |            |            |                                     |
R016  | Distribution coefficients for Pb-210         |            |            |                                     |
R016  |   Contaminated zone (cm**3/g)                | 1.000E+02  | 1.000E+02  |                ---                  | DCNUCC( 2)
R016  |   Unsaturated zone 1 (cm**3/g)               | not used   | 1.000E+02  |                ---                  | DCNUCU( 2,1)
R016  |   Saturated zone (cm**3/g)                   | not used   | 1.000E+02  |                ---                  | DCNUCS( 2)
R016  |   Leach rate (/yr)                           | 0.000E+00  | 0.000E+00  |             1.158E-03               | ALEACH( 2)
R016  |   Solubility constant                        | 0.000E+00  | 0.000E+00  |             not used                | SOLUBK( 2)
      |                                              |            |            |                                     |
R016  | Distribution coefficients for Th-230         |            |            |                                     |
R016  |   Contaminated zone (cm**3/g)                | 6.000E+04  | 6.000E+04  |                ---                  | DCNUCC( 4)
R016  |   Unsaturated zone 1 (cm**3/g)               | not used   | 6.000E+04  |                ---                  | DCNUCU( 4,1)
R016  |   Saturated zone (cm**3/g)                   | not used   | 6.000E+04  |                ---                  | DCNUCS( 4)
R016  |   Leach rate (/yr)                           | 0.000E+00  | 0.000E+00  |             1.933E-06               | ALEACH( 4)
R016  |   Solubility constant                        | 0.000E+00  | 0.000E+00  |             not used                | SOLUBK( 4)
      |                                              |            |            |                                     |
R016  | Distribution coefficients for U-234          |            |            |                                     |
R016  |   Contaminated zone (cm**3/g)                | 5.000E+01  | 5.000E+01  |                ---                  | DCNUCC( 5)
R016  |   Unsaturated zone 1 (cm**3/g)               | not used   | 5.000E+01  |                ---                  | DCNUCU( 5,1)
R016  |   Saturated zone (cm**3/g)                   | not used   | 5.000E+01  |                ---                  | DCNUCS( 5)
R016  |   Leach rate (/yr)                           | 0.000E+00  | 0.000E+00  |             2.312E-03               | ALEACH( 5)
R016  |   Solubility constant                        | 0.000E+00  | 0.000E+00  |             not used                | SOLUBK( 5)
      |                                              |            |            |                                     |
R016  | Distribution coefficients for U-238          |            |            |                                     |
R016  |   Contaminated zone (cm**3/g)                | 5.000E+01  | 5.000E+01  |                ---                  | DCNUCC( 6)
R016  |   Unsaturated zone 1 (cm**3/g)               | not used   | 5.000E+01  |                ---                  | DCNUCU( 6,1)
R016  |   Saturated zone (cm**3/g)                   | not used   | 5.000E+01  |                ---                  | DCNUCS( 6)
R016  |   Leach rate (/yr)                           | 0.000E+00  | 0.000E+00  |             2.312E-03               | ALEACH( 6)
R016  |   Solubility constant                        | 0.000E+00  | 0.000E+00  |             not used                | SOLUBK( 6)
```

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.653E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R017	Inhalation rate (m**3/yr)	5.000E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	1.000E+00	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	4.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.200E+02	3.650E+01	---	SOIL

```
                              Site-Specific Parameter Summary (continued)

     |                                                  |   User    |            |          Used by RESRAD          | Parameter
Menu |                   Parameter                      |   Input   |  Default   | (If different from user input)   |   Name
-----+--------------------------------------------------+-----------+------------+----------------------------------+--------------
STOR | Storage times of contaminated foodstuffs (days): |           |            |                                  |
STOR |   Fruits, non-leafy vegetables, and grain        | 1.400E+01 | 1.400E+01  |               ---                | STOR T(1)
STOR |   Leafy vegetables                               | 1.000E+00 | 1.000E+00  |               ---                | STOR T(2)
STOR |   Milk                                           | 1.000E+00 | 1.000E+00  |               ---                | STOR T(3)
STOR |   Meat and poultry                               | 2.000E+01 | 2.000E+01  |               ---                | STOR T(4)
STOR |   Fish                                           | 7.000E+00 | 7.000E+00  |               ---                | STOR T(5)
STOR |   Crustacea and mollusks                         | 7.000E+00 | 7.000E+00  |               ---                | STOR T(6)
STOR |   Well water                                     | 1.000E+00 | 1.000E+00  |               ---                | STOR T(7)
STOR |   Surface water                                  | 1.000E+00 | 1.000E+00  |               ---                | STOR T(8)
STOR |   Livestock fodder                               | 4.500E+01 | 4.500E+01  |               ---                | STOR_T(9)
     |                                                  |           |            |                                  |
R021 | Thickness of building foundation (m)             | not used  | 1.500E-01  |               ---                | FLOOR
R021 | Bulk density of building foundation (g/cm**3)    | not used  | 2.400E+00  |               ---                | DENSFL
R021 | Total porosity of the cover material             | not used  | 4.000E-01  |               ---                | TPCV
R021 | Total porosity of the building foundation        | not used  | 1.000E-01  |               ---                | TPFL
R021 | Volumetric water content of the cover material   | not used  | 5.000E-02  |               ---                | PH2OCV
R021 | Volumetric water content of the foundation       | not used  | 3.000E-02  |               ---                | PH2OFL
R021 | Diffusion coefficient for radon gas (m/sec):     |           |            |                                  |
R021 |   in cover material                              | not used  | 2.000E-06  |               ---                | DIFCV
R021 |   in foundation material                         | not used  | 3.000E-07  |               ---                | DIFFL
R021 |   in contaminated zone soil                      | not used  | 2.000E-06  |               ---                | DIFCZ
R021 | Radon vertical dimension of mixing (m)           | not used  | 2.000E+00  |               ---                | HMIX
R021 | Average building air exchange rate (1/hr)        | not used  | 5.000E-01  |               ---                | REXG
R021 | Height of the building (room) (m)                | not used  | 2.500E+00  |               ---                | HRM
R021 | Building interior area factor                    | not used  | 0.000E+00  |               ---                | FAI
R021 | Building depth below ground surface (m)          | not used  | -1.000E+00 |               ---                | DMFL
R021 | Emanating power of Rn-222 gas                    | not used  | 2.500E-01  |               ---                | EMANA(1)
R021 | Emanating power of Rn-220 gas                    | not used  | 1.500E-01  |               ---                | EMANA(2)
=====+==================================================+===========+============+==================================+==============


              Summary of Pathway Selections

          Pathway                  | User Selection
  ---------------------------------+---------------
   1 -- external gamma             |    active
   2 -- inhalation (w/o radon)     |    active
   3 -- plant ingestion            |  suppressed
   4 -- meat ingestion             |  suppressed
   5 -- milk ingestion             |  suppressed
   6 -- aquatic foods              |  suppressed
   7 -- drinking water             |  suppressed
   8 -- soil ingestion             |    active
   9 -- radon                      |  suppressed
   Find peak pathway doses         |  suppressed
  =================================+===============
```

```
                              Site-Specific Parameter Summary (continued)

     |                                                | User       |            |     Used by RESRAD               | Parameter
Menu |                Parameter                       | Input      | Default    | (If different from user input)   |   Name
-----+------------------------------------------------+------------+------------+----------------------------------+-----------
R018 | Drinking water intake (L/yr)                   | not used   | 5.100E+02  |              ---                 | DWI
R018 | Contamination fraction of drinking water       | not used   | 1.000E+00  |              ---                 | FDW
R018 | Contamination fraction of household water      | not used   | 1.000E+00  |              ---                 | FHHW
R018 | Contamination fraction of livestock water      | not used   | 1.000E+00  |              ---                 | FLW
R018 | Contamination fraction of irrigation water     | not used   | 1.000E+00  |              ---                 | FIRW
R018 | Contamination fraction of aquatic food         | not used   | 5.000E-01  |              ---                 | FR9
R018 | Contamination fraction of plant food           | not used   |-1          |              ---                 | FPLANT
R018 | Contamination fraction of meat                 | not used   |-1          |              ---                 | FMEAT
R018 | Contamination fraction of milk                 | not used   |-1          |              ---                 | FMILK
     |                                                |            |            |                                  |
R019 | Livestock fodder intake for meat (kg/day)      | not used   | 6.800E+01  |              ---                 | LFI5
R019 | Livestock fodder intake for milk (kg/day)      | not used   | 5.500E+01  |              ---                 | LFI6
R019 | Livestock water intake for meat (L/day)        | not used   | 5.000E+01  |              ---                 | LWI5
R019 | Livestock water intake for milk (L/day)        | not used   | 1.600E+02  |              ---                 | LWI6
R019 | Livestock soil intake (kg/day)                 | not used   | 5.000E-01  |              ---                 | LSI
R019 | Mass loading for foliar deposition (g/m**3)    | not used   | 1.000E-04  |              ---                 | MLFD
R019 | Depth of soil mixing layer (m)                 | 1.500E-01  | 1.500E-01  |              ---                 | DM
R019 | Depth of roots (m)                             | not used   | 9.000E-01  |              ---                 | DROOT
R019 | Drinking water fraction from ground water      | 1.000E+00  | 1.000E+00  |              ---                 | FGWDW
R019 | Household water fraction from ground water     | not used   | 1.000E+00  |              ---                 | FGWHH
R019 | Livestock water fraction from ground water     | not used   | 1.000E+00  |              ---                 | FGWLW
R019 | Irrigation fraction from ground water          | not used   | 1.000E+00  |              ---                 | FGWIR
     |                                                |            |            |                                  |
R19B | Wet weight crop yield for Non-Leafy (kg/m**2)  | not used   | 7.000E-01  |              ---                 | YV(1)
R19B | Wet weight crop yield for Leafy     (kg/m**2)  | not used   | 1.500E+00  |              ---                 | YV(2)
R19B | Wet weight crop yield for Fodder    (kg/m**2)  | not used   | 1.100E+00  |              ---                 | YV(3)
R19B | Growing Season for  Non-Leafy (years)          | not used   | 1.700E-01  |              ---                 | TE(1)
R19B | Growing Season for  Leafy     (years)          | not used   | 2.500E-01  |              ---                 | TE(2)
R19B | Growing Season for  Fodder    (years)          | not used   | 8.000E-02  |              ---                 | TE(3)
R19B | Translocation Factor for  Non-Leafy            | not used   | 1.000E-01  |              ---                 | TIV(1)
R19B | Translocation Factor for  Leafy                | not used   | 1.000E+00  |              ---                 | TIV(2)
R19B | Translocation Factor for  Fodder               | not used   | 1.000E+00  |              ---                 | TIV(3)
R19B | Dry Foliar Interception Fraction for  Non-Leafy| not used   | 2.500E-01  |              ---                 | RDRY(1)
R19B | Dry Foliar Interception Fraction for  Leafy    | not used   | 2.500E-01  |              ---                 | RDRY(2)
R19B | Dry Foliar Interception Fraction for  Fodder   | not used   | 2.500E-01  |              ---                 | RDRY(3)
R19B | Wet Foliar Interception Fraction for  Non-Leafy| not used   | 2.500E-01  |              ---                 | RWET(1)
R19B | Wet Foliar Interception Fraction for  Leafy    | not used   | 2.500E-01  |              ---                 | RWET(2)
R19B | Wet Foliar Interception Fraction for  Fodder   | not used   | 2.500E-01  |              ---                 | RWET(3)
R19B | Weathering Removal Constant for Vegetation     | not used   | 2.000E+01  |              ---                 | WLAM
     |                                                |            |            |                                  |
C14  | C-12 concentration in water (g/cm**3)          | not used   | 2.000E-05  |              ---                 | C12WTR
C14  | C-12 concentration in contaminated soil (g/g)  | not used   | 3.000E-02  |              ---                 | C12CZ
C14  | Fraction of vegetation carbon from soil        | not used   | 2.000E-02  |              ---                 | CSOIL
C14  | Fraction of vegetation carbon from air         | not used   | 9.800E-01  |              ---                 | CAIR
C14  | C-14 evasion layer thickness in soil (m)       | not used   | 3.000E-01  |              ---                 | DMC
C14  | C-14 evasion flux rate from soil (1/sec)       | not used   | 7.000E-07  |              ---                 | EVSN
C14  | C-12 evasion flux rate from soil (1/sec)       | not used   | 1.000E-10  |              ---                 | REVSN
C14  | Fraction of grain in beef cattle feed          | not used   | 8.000E-01  |              ---                 | AVFG4
C14  | Fraction of grain in milk cow feed             | not used   | 2.000E-01  |              ---                 | AVFG5
     |                                                |            |            |                                  |
```

```
     Contaminated Zone Dimensions              Initial Soil Concentrations, pCi/g
     ____________________________              __________________________________

        Area:  65000.00 square meters                  Cs-137     1.500E+00
   Thickness:      1.00 meters                         Pb-210     9.100E+00
 Cover Depth:      0.00 meters                         Th-230     2.200E+00
                                                       U-234      1.300E+00
                                                       U-238      1.400E+00


                                        Total Dose TDOSE(t), mrem/yr
                                  Basic Radiation Dose Limit =  10 mrem/yr
                  Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                  ____________________________________________________________________________

   t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
    TDOSE(t):  6.828E+00  6.650E+00  5.992E+00  5.275E+00  3.675E+00  2.665E+00  2.033E+00  1.642E+00
        M(t):  6.828E-01  6.650E-01  5.992E-01  5.275E-01  3.675E-01  2.665E-01  2.033E-01  1.642E-01

Maximum TDOSE(t):  6.828E+00 mrem/yr    at t = 0.000E+00 years
```

```
                             Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                         As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                            Water Independent Pathways (Inhalation excludes radon)

            Ground            Inhalation          Radon              Plant              Meat               Milk               Soil
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  2.324E+00 0.3404  1.125E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.500E-03 0.0007
Pb-210  2.601E-02 0.0038  4.963E-02 0.0073  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.969E+00 0.5814
Th-230  1.234E-03 0.0002  1.686E-01 0.0247  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.234E-02 0.0106
U-234   2.432E-04 0.0000  4.034E-02 0.0059  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.207E-02 0.0032
U-238   8.760E-02 0.0128  3.884E-02 0.0057  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.260E-02 0.0033
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   2.439E+00 0.3573  2.974E-01 0.0436  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.091E+00 0.5992

                             Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                         As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                        Water Dependent Pathways

            Water              Fish              Radon              Plant              Meat               Milk          All Pathways*
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.329E+00 0.3411
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.045E+00 0.5924
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.422E-01 0.0355
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.266E-02 0.0092
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.490E-01 0.0218
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.828E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                        Water Independent Pathways (Inhalation excludes radon)

            Ground            Inhalation           Radon              Plant              Meat               Milk               Soil
Radio-  ------------------ ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------
Cs-137  2.271E+00 0.3415 1.099E-05 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.397E-03 0.0007
Pb-210  2.518E-02 0.0038 4.806E-02 0.0072 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.843E+00 0.5779
Th-230  6.092E-03 0.0009 1.686E-01 0.0254 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 7.242E-02 0.0109
U-234   2.426E-04 0.0000 4.025E-02 0.0061 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.202E-02 0.0033
U-238   8.740E-02 0.0131 3.875E-02 0.0058 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.254E-02 0.0034
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
Total   2.390E+00 0.3594 2.957E-01 0.0445 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.965E+00 0.5962

                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                       Water Dependent Pathways

            Water              Fish               Radon              Plant              Meat               Milk          All Pathways*
Radio-  ------------------ ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------
Cs-137  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.275E+00 0.3421
Pb-210  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.917E+00 0.5889
Th-230  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.471E-01 0.0372
U-234   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 6.251E-02 0.0094
U-238   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.487E-01 0.0224
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
Total   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 6.650E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                 As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                    Water Independent Pathways (Inhalation excludes radon)

                  Ground              Inhalation              Radon                Plant                 Meat                 Milk                 Soil
Radio-   --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
Nuclide   mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------
Cs-137   2.070E+00 0.3453  1.002E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.007E-03 0.0007
Pb-210   2.214E-02 0.0037  4.224E-02 0.0070  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.378E+00 0.5638
Th-230   2.542E-02 0.0042  1.686E-01 0.0281  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.286E-02 0.0122
U-234    2.407E-04 0.0000  3.988E-02 0.0067  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.182E-02 0.0036
U-238    8.659E-02 0.0145  3.839E-02 0.0064  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.234E-02 0.0037
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    2.204E+00 0.3678  2.891E-01 0.0482  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.499E+00 0.5840

                                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                 As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                                  Water Dependent Pathways

                  Water                 Fish                 Radon                Plant                 Meat                 Milk             All Pathways*
Radio-   --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
Nuclide   mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------
Cs-137   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.074E+00 0.3460
Pb-210   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.443E+00 0.5745
Th-230   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.669E-01 0.0445
U-234    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.194E-02 0.0103
U-238    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.473E-01 0.0246
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.992E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                      Water Independent Pathways (Inhalation excludes radon)

             Ground            Inhalation           Radon              Plant              Meat               Milk               Soil
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- -------
Cs-137  1.843E+00 0.3493  8.918E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.568E-03 0.0007
Pb-210  1.884E-02 0.0036  3.595E-02 0.0068  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.875E+00 0.5451
Th-230  4.936E-02 0.0094  1.686E-01 0.0320  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.366E-02 0.0140
U-234   2.390E-04 0.0000  3.943E-02 0.0075  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.157E-02 0.0041
U-238   8.560E-02 0.0162  3.795E-02 0.0072  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.208E-02 0.0042
======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= =======
Total   1.997E+00 0.3785  2.819E-01 0.0534  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.996E+00 0.5680


                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                     Water Dependent Pathways

             Water              Fish              Radon              Plant              Meat               Milk          All Pathways*
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- -------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.846E+00 0.3500
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.930E+00 0.5555
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.916E-01 0.0553
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.124E-02 0.0116
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.456E-01 0.0276
======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= =======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.275E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                   Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                  Water Independent Pathways (Inhalation excludes radon)

               Ground             Inhalation            Radon               Plant               Meat                Milk                Soil
Radio-  ------------------- ------------------- ------------------- ------------------- ------------------- ------------------- -------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------- ------- ---------- ------- ---------- ------- ---------- ------- ---------- ------- ---------- ------- ---------- -------
Cs-137  1.301E+00 0.3539  6.295E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.518E-03 0.0007
Pb-210  1.162E-02 0.0032  2.217E-02 0.0060  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.773E+00 0.4824
Th-230  1.197E-01 0.0326  1.686E-01 0.0459  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.725E-02 0.0210
U-234   2.375E-04 0.0001  3.809E-02 0.0104  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.084E-02 0.0057
U-238   8.268E-02 0.0225  3.666E-02 0.0100  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.133E-02 0.0058
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.515E+00 0.4122  2.656E-01 0.0723  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.895E+00 0.5156

                   Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                  Water Dependent Pathways

               Water                Fish                Radon               Plant               Meat                Milk           All Pathways*
Radio-  ------------------- ------------------- ------------------- ------------------- ------------------- ------------------- -------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------- ------- ---------- ------- ---------- ------- ---------- ------- ---------- ------- ---------- ------- ---------- -------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.303E+00 0.3546
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.807E+00 0.4916
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.656E-01 0.0995
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.917E-02 0.0161
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.407E-01 0.0383
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.675E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
           Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                         As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                              Water Independent Pathways (Inhalation excludes radon)

              Ground            Inhalation            Radon              Plant               Meat               Milk               Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137  9.181E-01 0.3445    4.443E-06 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.778E-03 0.0007
Pb-210  7.162E-03 0.0027    1.367E-02 0.0051    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.093E+00 0.4101
Th-230  1.879E-01 0.0705    1.687E-01 0.0633    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.204E-02 0.0308
U-234   2.414E-04 0.0001    3.681E-02 0.0138    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.014E-02 0.0076
U-238   7.986E-02 0.0300    3.541E-02 0.0133    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.060E-02 0.0077
======= =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total   1.193E+00 0.4477    2.546E-01 0.0955    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.218E+00 0.4568

           Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                         As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                            Water Dependent Pathways

              Water              Fish               Radon              Plant               Meat               Milk           All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.199E-01 0.3451
Pb-210  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.114E+00 0.4179
Th-230  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.386E-01 0.1645
U-234   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.718E-02 0.0215
U-238   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.359E-01 0.0510
======= =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.665E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                             As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                               Water Independent Pathways (Inhalation excludes radon)

            Ground             Inhalation            Radon               Plant               Meat                Milk                Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  6.481E-01 0.3188  3.136E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.255E-03 0.0006
Pb-210  4.416E-03 0.0022  8.426E-03 0.0041  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.739E-01 0.3315
Th-230  2.539E-01 0.1249  1.687E-01 0.0830  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.747E-02 0.0430
U-234   2.506E-04 0.0001  3.556E-02 0.0175  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.946E-02 0.0096
U-238   7.714E-02 0.0379  3.420E-02 0.0168  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.990E-02 0.0098
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   9.838E-01 0.4840  2.469E-01 0.1215  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.020E-01 0.3945


                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                             As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                             Water Dependent Pathways

            Water               Fish               Radon               Plant               Meat                Milk           All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.493E-01 0.3194
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.868E-01 0.3379
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.101E-01 0.2510
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.527E-02 0.0272
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.312E-01 0.0646
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.033E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                  Water Independent Pathways (Inhalation excludes radon)

Radio-        Ground            Inhalation           Radon              Plant              Meat               Milk               Soil
         ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
-------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137   4.575E-01 0.2786  2.214E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.857E-04 0.0005
Pb-210   2.723E-03 0.0017  5.195E-03 0.0032  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.155E-01 0.2531
Th-230   3.179E-01 0.1936  1.688E-01 0.1028  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.324E-02 0.0568
U-234    2.645E-04 0.0002  3.436E-02 0.0209  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.880E-02 0.0114
U-238    7.451E-02 0.0454  3.304E-02 0.0201  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.922E-02 0.0117
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    8.529E-01 0.5194  2.414E-01 0.1470  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.477E-01 0.3335

                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                 Water Dependent Pathways

Radio-        Water              Fish              Radon              Plant              Meat               Milk          All Pathways*
         ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
-------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.584E-01 0.2792
Pb-210   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.234E-01 0.2579
Th-230   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.800E-01 0.3532
U-234    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.343E-02 0.0325
U-238    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.268E-01 0.0772
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.642E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                            Dose/Source Ratios Summed Over All Pathways
                   Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                              DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)      (j)     Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
-------  -------  ---------    --------- --------- --------- --------- --------- --------- --------- ---------
Cs-137   Cs-137   1.000E+00    1.553E+00 1.517E+00 1.382E+00 1.231E+00 8.688E-01 6.133E-01 4.329E-01 3.056E-01

Pb-210   Pb-210   1.000E+00    4.445E-01 4.304E-01 3.783E-01 3.220E-01 1.985E-01 1.224E-01 7.547E-02 4.653E-02

Th-230   Th-230   1.000E+00    1.101E-01 1.101E-01 1.101E-01 1.101E-01 1.100E-01 1.100E-01 1.100E-01 1.100E-01
Th-230   Ra-226   1.000E+00    0.000E+00 2.244E-03 1.117E-02 2.223E-02 5.470E-02 8.617E-02 1.167E-01 1.462E-01
Th-230   Pb-210   1.000E+00    0.000E+00 2.959E-06 7.071E-05 2.676E-04 1.428E-03 3.156E-03 5.202E-03 7.413E-03
Th-230   ∑DSR(j)               1.101E-01 1.123E-01 1.213E-01 1.326E-01 1.662E-01 1.994E-01 2.319E-01 2.636E-01

U-234    U-234    1.000E+00    4.820E-02 4.809E-02 4.764E-02 4.709E-02 4.549E-02 4.393E-02 4.244E-02 4.099E-02
U-234    Th-230   1.000E+00    0.000E+00 9.897E-07 4.926E-06 9.795E-06 2.407E-05 3.785E-05 5.116E-05 6.401E-05
U-234    Ra-226   1.000E+00    0.000E+00 1.009E-08 2.509E-07 9.962E-07 6.091E-06 1.525E-05 2.822E-05 4.472E-05
U-234    Pb-210   1.000E+00    0.000E+00 8.899E-12 1.073E-09 8.208E-09 1.128E-07 4.091E-07 9.480E-07 1.752E-06
U-234    ∑DSR(j)               4.820E-02 4.809E-02 4.765E-02 4.711E-02 4.552E-02 4.399E-02 4.252E-02 4.110E-02

U-238    U-238    1.000E+00    1.065E-01 1.062E-01 1.052E-01 1.040E-01 1.005E-01 9.705E-02 9.374E-02 9.054E-02
U-238    U-234    1.000E+00    0.000E+00 1.363E-07 6.753E-07 1.335E-06 3.224E-06 4.982E-06 6.617E-06 8.135E-06
U-238    Th-230   1.000E+00    0.000E+00 1.402E-12 3.484E-11 1.383E-10 8.447E-10 2.113E-09 3.904E-09 6.181E-09
U-238    Ra-226   1.000E+00    0.000E+00 9.539E-15 1.184E-12 9.394E-12 1.431E-10 5.717E-10 1.449E-09 2.914E-09
U-238    Pb-210   1.000E+00    0.000E+00 6.417E-18 3.827E-15 5.895E-14 2.061E-12 1.216E-11 3.927E-11 9.351E-11
U-238    ∑DSR(j)               1.065E-01 1.062E-01 1.052E-01 1.040E-01 1.005E-01 9.705E-02 9.375E-02 9.055E-02
=======  =======  =========    ========= ========= ========= ========= ========= ========= ========= =========
*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.


                         Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                              Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)     t= 0.000E+00   1.000E+00   5.000E+00   1.000E+01   2.500E+01   4.000E+01   5.500E+01   7.000E+01
-------      ---------   ---------   ---------   ---------   ---------   ---------   ---------   ---------
Cs-137       6.441E+00   6.592E+00   7.234E+00   8.125E+00   1.151E+01   1.631E+01   2.310E+01   3.273E+01
Pb-210       2.250E+01   2.323E+01   2.643E+01   3.106E+01   5.037E+01   8.170E+01   1.325E+02   2.149E+02
Th-230       9.085E+01   8.903E+01   8.243E+01   7.544E+01   6.018E+01   5.016E+01   4.313E+01   3.793E+01
U-234        2.075E+02   2.080E+02   2.099E+02   2.123E+02   2.197E+02   2.273E+02   2.352E+02   2.433E+02
U-238        9.394E+01   9.416E+01   9.503E+01   9.614E+01   9.953E+01   1.030E+02   1.067E+02   1.104E+02
=======      =========   =========   =========   =========   =========   =========   =========   =========
```

```
               Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
               and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
            at tmin = time of minimum single radionuclide soil guideline
        and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide  Initial         tmin          DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
  (i)     pCi/g         (years)                     (pCi/g)               (pCi/g)
_______  _________    ________________   _________  _________  _________  _________

Cs-137   1.500E+00       0.000E+00       1.553E+00  6.441E+00  1.553E+00  6.441E+00
Pb-210   9.100E+00       0.000E+00       4.445E-01  2.250E+01  4.445E-01  2.250E+01
Th-230   2.200E+00       7.000E+01       2.636E-01  3.793E+01  1.101E-01  9.085E+01
U-234    1.300E+00       0.000E+00       4.820E-02  2.075E+02  4.820E-02  2.075E+02
U-238    1.400E+00       0.000E+00       1.065E-01  9.394E+01  1.065E-01  9.394E+01
=======  =========    ================   =========  =========  =========  =========
```

```
                                   Individual Nuclide Dose Summed Over All Pathways
                                     Parent Nuclide and Branch Fraction Indicated

Nuclide Parent    BRF(i)                                           DOSE(j,t), mrem/yr
  (j)     (i)                t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
------- -------- ---------       --------- --------- --------- --------- --------- --------- --------- ---------
Cs-137  Cs-137   1.000E+00       2.329E+00 2.275E+00 2.074E+00 1.846E+00 1.303E+00 9.199E-01 6.493E-01 4.584E-01

Pb-210  Pb-210   1.000E+00       4.045E+00 3.917E+00 3.443E+00 2.930E+00 1.807E+00 1.114E+00 6.868E-01 4.234E-01
Pb-210  Th-230   1.000E+00       0.000E+00 6.509E-06 1.556E-04 5.888E-04 3.142E-03 6.943E-03 1.144E-02 1.631E-02
Pb-210  U-234    1.000E+00       0.000E+00 1.157E-11 1.395E-09 1.067E-08 1.466E-07 5.319E-07 1.232E-06 2.278E-06
Pb-210  U-238    1.000E+00       0.000E+00 8.984E-18 5.358E-15 8.253E-14 2.886E-12 1.702E-11 5.498E-11 1.309E-10
Pb-210  ∑DOSE(j):                4.045E+00 3.917E+00 3.443E+00 2.931E+00 1.810E+00 1.121E+00 6.982E-01 4.397E-01

Th-230  Th-230   1.000E+00       2.422E-01 2.422E-01 2.422E-01 2.421E-01 2.421E-01 2.421E-01 2.420E-01 2.420E-01
Th-230  U-234    1.000E+00       0.000E+00 1.287E-06 6.404E-06 1.273E-05 3.129E-05 4.920E-05 6.650E-05 8.321E-05
Th-230  U-238    1.000E+00       0.000E+00 1.963E-12 4.878E-11 1.936E-10 1.183E-09 2.958E-09 5.466E-09 8.653E-09
Th-230  ∑DOSE(j):                2.422E-01 2.422E-01 2.422E-01 2.422E-01 2.421E-01 2.421E-01 2.421E-01 2.421E-01

Ra-226  Th-230   1.000E+00       0.000E+00 4.936E-03 2.458E-02 4.890E-02 1.203E-01 1.896E-01 2.567E-01 3.217E-01
Ra-226  U-234    1.000E+00       0.000E+00 1.312E-08 3.261E-07 1.295E-06 7.918E-06 1.983E-05 3.668E-05 5.813E-05
Ra-226  U-238    1.000E+00       0.000E+00 1.335E-14 1.658E-12 1.315E-11 2.004E-10 8.004E-10 2.029E-09 4.080E-09
Ra-226  ∑DOSE(j):                0.000E+00 4.936E-03 2.458E-02 4.890E-02 1.204E-01 1.896E-01 2.567E-01 3.217E-01

U-234   U-234    1.000E+00       6.266E-02 6.251E-02 6.194E-02 6.122E-02 5.913E-02 5.712E-02 5.517E-02 5.328E-02
U-234   U-238    1.000E+00       0.000E+00 1.909E-07 9.455E-07 1.869E-06 4.514E-06 6.975E-06 9.264E-06 1.139E-05
U-234   ∑DOSE(j):                6.266E-02 6.251E-02 6.194E-02 6.122E-02 5.914E-02 5.712E-02 5.518E-02 5.329E-02

U-238   U-238    1.000E+00       1.490E-01 1.487E-01 1.473E-01 1.456E-01 1.407E-01 1.359E-01 1.312E-01 1.268E-01
======= ======== =========       ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
```

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                                 Individual Nuclide Soil Concentration
                              Parent Nuclide and Branch Fraction Indicated

Nuclide Parent   BRF(i)                                       S(j,t), pCi/g
  (j)     (i)             t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ _______ _________    _________ _________ _________ _________ _________ _________ _________ _________

Cs-137  Cs-137  1.000E+00    1.500E+00 1.466E+00 1.336E+00 1.189E+00 8.394E-01 5.925E-01 4.182E-01 2.952E-01

Pb-210  Pb-210  1.000E+00    9.100E+00 8.811E+00 7.745E+00 6.592E+00 4.064E+00 2.506E+00 1.545E+00 9.526E-01
Pb-210  Th-230  1.000E+00    0.000E+00 1.464E-05 3.499E-04 1.325E-03 7.068E-03 1.562E-02 2.574E-02 3.669E-02
Pb-210  U-234   1.000E+00    0.000E+00 2.602E-11 3.137E-09 2.401E-08 3.299E-07 1.197E-06 2.772E-06 5.125E-06
Pb-210  U-238   1.000E+00    0.000E+00 2.021E-17 1.205E-14 1.857E-13 6.493E-12 3.828E-11 1.237E-10 2.945E-10
Pb-210  ∑S(j):               9.100E+00 8.811E+00 7.746E+00 6.593E+00 4.071E+00 2.521E+00 1.571E+00 9.893E-01

Th-230  Th-230  1.000E+00    2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00 2.198E+00
Th-230  U-234   1.000E+00    0.000E+00 1.169E-05 5.817E-05 1.157E-04 2.842E-04 4.470E-04 6.042E-04 7.559E-04
Th-230  U-238   1.000E+00    0.000E+00 1.784E-11 4.432E-10 1.759E-09 1.074E-08 2.687E-08 4.966E-08 7.861E-08
Th-230  ∑S(j):               2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00

Ra-226  Th-230  1.000E+00    0.000E+00 9.521E-04 4.740E-03 9.432E-03 2.321E-02 3.657E-02 4.951E-02 6.205E-02
Ra-226  U-234   1.000E+00    0.000E+00 2.531E-09 6.291E-08 2.498E-07 1.527E-06 3.825E-06 7.075E-06 1.121E-05
Ra-226  U-238   1.000E+00    0.000E+00 2.576E-15 3.198E-13 2.537E-12 3.865E-11 1.544E-10 3.914E-10 7.870E-10
Ra-226  ∑S(j):               0.000E+00 9.521E-04 4.741E-03 9.432E-03 2.321E-02 3.657E-02 4.952E-02 6.206E-02

U-234   U-234   1.000E+00    1.300E+00 1.297E+00 1.285E+00 1.270E+00 1.227E+00 1.185E+00 1.145E+00 1.106E+00
U-234   U-238   1.000E+00    0.000E+00 3.960E-06 1.962E-05 3.878E-05 9.365E-05 1.447E-04 1.922E-04 2.363E-04
U-234   ∑S(j):               1.300E+00 1.297E+00 1.285E+00 1.270E+00 1.227E+00 1.185E+00 1.145E+00 1.106E+00

U-238   U-238   1.000E+00    1.400E+00 1.397E+00 1.384E+00 1.368E+00 1.321E+00 1.276E+00 1.233E+00 1.191E+00
======= ======= =========    ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
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RESRAD OUTPUT FOR PARK WORKER – SEDIMENT SUPPORT FOR COMPLIANCE WITH NYSDEC TAGM

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                         Table of Contents
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   Part I: Mixture Sums and Single Radionuclide Guidelines
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                     Dose Conversion Factor (and Related) Parameter Summary
                                        File: DOSFAC.BIN

     |                                                       |  Current  |           |  Parameter
Menu |                       Parameter                       |   Value   |  Default  |    Name
-----+-------------------------------------------------------+-----------+-----------+--------------
B-1  | Dose conversion factors for inhalation, mrem/pCi:     |           |           |
B-1  | Cs-137+D                                              | 3.190E-05 | 3.190E-05 | DCF2( 1)
B-1  | Pb-210+D                                              | 2.320E-02 | 2.320E-02 | DCF2( 2)
B-1  | Ra-226+D                                              | 8.600E-03 | 8.600E-03 | DCF2( 3)
B-1  | Th-230                                                | 3.260E-01 | 3.260E-01 | DCF2( 4)
B-1  | U-234                                                 | 1.320E-01 | 1.320E-01 | DCF2( 5)
B-1  | U-238+D                                               | 1.180E-01 | 1.180E-01 | DCF2( 6)
     |                                                       |           |           |
D-1  | Dose conversion factors for ingestion, mrem/pCi:      |           |           |
D-1  | Cs-137+D                                              | 5.000E-05 | 5.000E-05 | DCF3( 1)
D-1  | Pb-210+D                                              | 7.270E-03 | 7.270E-03 | DCF3( 2)
D-1  | Ra-226+D                                              | 1.330E-03 | 1.330E-03 | DCF3( 3)
D-1  | Th-230                                                | 5.480E-04 | 5.480E-04 | DCF3( 4)
D-1  | U-234                                                 | 2.830E-04 | 2.830E-04 | DCF3( 5)
D-1  | U-238+D                                               | 2.690E-04 | 2.690E-04 | DCF3( 6)
     |                                                       |           |           |
D-34 | Food transfer factors:                                |           |           |
D-34 | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 1,1)
D-34 | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 1,2)
D-34 | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 8.000E-03 | 8.000E-03 | RTF( 1,3)
D-34 |                                                       |           |           |
D-34 | Pb-210+D , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 2,1)
D-34 | Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04 | 8.000E-04 | RTF( 2,2)
D-34 | Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 3.000E-04 | 3.000E-04 | RTF( 2,3)
D-34 |                                                       |           |           |
D-34 | Ra-226+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 3,1)
D-34 | Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF( 3,2)
D-34 | Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03 | 1.000E-03 | RTF( 3,3)
D-34 |                                                       |           |           |
D-34 | Th-230   , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 4,1)
D-34 | Th-230   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 4,2)
D-34 | Th-230   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF( 4,3)
D-34 |                                                       |           |           |
D-34 | U-234    , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 5,1)
D-34 | U-234    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 5,2)
D-34 | U-234    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF( 5,3)
D-34 |                                                       |           |           |
D-34 | U-238+D  , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 6,1)
D-34 | U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 6,2)
D-34 | U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF( 6,3)
     |                                                       |           |           |
D-5  | Bioaccumulation factors, fresh water, L/kg:           |           |           |
D-5  | Cs-137+D , fish                                       | 2.000E+03 | 2.000E+03 | BIOFAC( 1,1)
D-5  | Cs-137+D , crustacea and mollusks                     | 1.000E+02 | 1.000E+02 | BIOFAC( 1,2)
D-5  |                                                       |           |           |
D-5  | Pb-210+D , fish                                       | 3.000E+02 | 3.000E+02 | BIOFAC( 2,1)
D-5  | Pb-210+D , crustacea and mollusks                     | 1.000E+02 | 1.000E+02 | BIOFAC( 2,2)
D-5  |                                                       |           |           |
D-5  | Ra-226+D , fish                                       | 5.000E+01 | 5.000E+01 | BIOFAC( 3,1)
D-5  | Ra-226+D , crustacea and mollusks                     | 2.500E+02 | 2.500E+02 | BIOFAC( 3,2)
D-5  |                                                       |           |           |
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                         Dose Conversion Factor (and Related) Parameter Summary (continued)
                                                 File: DOSFAC.BIN

     |                                                             |  Current   |            | Parameter
Menu |                        Parameter                            |   Value    |  Default   |   Name
-----+-------------------------------------------------------------+------------+------------+---------------
D-5  | Th-230    , fish                                            | 1.000E+02  | 1.000E+02  | BIOFAC( 4,1)
D-5  | Th-230    , crustacea and mollusks                          | 5.000E+02  | 5.000E+02  | BIOFAC( 4,2)
D-5  |                                                             |            |            |
D-5  | U-234     , fish                                            | 1.000E+01  | 1.000E+01  | BIOFAC( 5,1)
D-5  | U-234     , crustacea and mollusks                          | 6.000E+01  | 6.000E+01  | BIOFAC( 5,2)
D-5  |                                                             |            |            |
D-5  | U-238+D   , fish                                            | 1.000E+01  | 1.000E+01  | BIOFAC( 6,1)
D-5  | U-238+D   , crustacea and mollusks                          | 6.000E+01  | 6.000E+01  | BIOFAC( 6,2)
=====+=============================================================+============+============+===============
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                                                                Site-Specific Parameter Summary

     |                                                           |   User     |            |         Used by RESRAD            |  Parameter
Menu |                        Parameter                          |   Input    |  Default   | (If different from user input)    |    Name
-----+-----------------------------------------------------------+------------+------------+-----------------------------------+-------------
R011 | Area of contaminated zone (m**2)                          | 6.500E+04  | 1.000E+04  |                ---                | AREA
R011 | Thickness of contaminated zone (m)                        | 1.000E+00  | 2.000E+00  |                ---                | THICK0
R011 | Length parallel to aquifer flow (m)                       | 6.100E+01  | 1.000E+02  |                ---                | LCZPAQ
R011 | Basic radiation dose limit (mrem/yr)                      | 1.000E+01  | 3.000E+01  |                ---                | BRDL
R011 | Time since placement of material (yr)                     | 0.000E+00  | 0.000E+00  |                ---                | TI
R011 | Times for calculations (yr)                               | 1.000E+00  | 1.000E+00  |                ---                | T( 2)
R011 | Times for calculations (yr)                               | 5.000E+00  | 3.000E+00  |                ---                | T( 3)
R011 | Times for calculations (yr)                               | 1.000E+01  | 1.000E+01  |                ---                | T( 4)
R011 | Times for calculations (yr)                               | 2.500E+01  | 3.000E+01  |                ---                | T( 5)
R011 | Times for calculations (yr)                               | 4.000E+01  | 1.000E+02  |                ---                | T( 6)
R011 | Times for calculations (yr)                               | 5.500E+01  | 3.000E+02  |                ---                | T( 7)
R011 | Times for calculations (yr)                               | 7.000E+01  | 1.000E+03  |                ---                | T( 8)
R011 | Times for calculations (yr)                               | not used   | 0.000E+00  |                ---                | T( 9)
R011 | Times for calculations (yr)                               | not used   | 0.000E+00  |                ---                | T(10)
     |                                                           |            |            |                                   |
R012 | Initial principal radionuclide (pCi/g):   Cs-137          | 1.500E+00  | 0.000E+00  |                ---                | S1( 1)
R012 | Initial principal radionuclide (pCi/g):   Pb-210          | 9.100E+00  | 0.000E+00  |                ---                | S1( 2)
R012 | Initial principal radionuclide (pCi/g):   Th-230          | 2.200E+00  | 0.000E+00  |                ---                | S1( 4)
R012 | Initial principal radionuclide (pCi/g):   U-234           | 1.300E+00  | 0.000E+00  |                ---                | S1( 5)
R012 | Initial principal radionuclide (pCi/g):   U-238           | 1.400E+00  | 0.000E+00  |                ---                | S1( 6)
R012 | Concentration in groundwater   (pCi/L):   Cs-137          | not used   | 0.000E+00  |                ---                | W1( 1)
R012 | Concentration in groundwater   (pCi/L):   Pb-210          | not used   | 0.000E+00  |                ---                | W1( 2)
R012 | Concentration in groundwater   (pCi/L):   Th-230          | not used   | 0.000E+00  |                ---                | W1( 4)
R012 | Concentration in groundwater   (pCi/L):   U-234           | not used   | 0.000E+00  |                ---                | W1( 5)
R012 | Concentration in groundwater   (pCi/L):   U-238           | not used   | 0.000E+00  |                ---                | W1( 6)
     |                                                           |            |            |                                   |
R013 | Cover depth (m)                                           | 0.000E+00  | 0.000E+00  |                ---                | COVER0
R013 | Density of cover material (g/cm**3)                       | not used   | 1.500E+00  |                ---                | DENSCV
R013 | Cover depth erosion rate (m/yr)                           | not used   | 1.000E-03  |                ---                | VCV
R013 | Density of contaminated zone (g/cm**3)                    | 1.500E+00  | 1.500E+00  |                ---                | DENSCZ
R013 | Contaminated zone erosion rate (m/yr)                     | 6.000E-05  | 1.000E-03  |                ---                | VCZ
R013 | Contaminated zone total porosity                          | 3.700E-01  | 4.000E-01  |                ---                | TPCZ
R013 | Contaminated zone effective porosity                      | 1.750E-01  | 2.000E-01  |                ---                | EPCZ
R013 | Contaminated zone hydraulic conductivity (m/yr)           | 2.080E+02  | 1.000E+01  |                ---                | HCCZ
R013 | Contaminated zone b parameter                             | 7.750E+00  | 5.300E+00  |                ---                | BCZ
R013 | Average annual wind speed (m/sec)                         | 3.000E+00  | 2.000E+00  |                ---                | WIND
R013 | Humidity in air (g/m**3)                                  | not used   | 8.000E+00  |                ---                | HUMID
R013 | Evapotranspiration coefficient                            | 7.100E-01  | 5.000E-01  |                ---                | EVAPTR
R013 | Precipitation (m/yr)                                      | 7.500E-01  | 1.000E+00  |                ---                | PRECIP
R013 | Irrigation (m/yr)                                         | 0.000E+00  | 2.000E-01  |                ---                | RI
R013 | Irrigation mode                                           | overhead   | overhead   |                ---                | IDITCH
R013 | Runoff coefficient                                        | 2.000E-01  | 2.000E-01  |                ---                | RUNOFF
R013 | Watershed area for nearby stream or pond (m**2)           | 1.300E+07  | 1.000E+06  |                ---                | WAREA
R013 | Accuracy for water/soil computations                      | 1.000E-03  | 1.000E-03  |                ---                | EPS
     |                                                           |            |            |                                   |
R014 | Density of saturated zone (g/cm**3)                       | 1.500E+00  | 1.500E+00  |                ---                | DENSAQ
R014 | Saturated zone total porosity                             | 3.700E-01  | 4.000E-01  |                ---                | TPSZ
R014 | Saturated zone effective porosity                         | 1.750E-01  | 2.000E-01  |                ---                | EPSZ
R014 | Saturated zone hydraulic conductivity (m/yr)              | 2.080E+02  | 1.000E+02  |                ---                | HCSZ
R014 | Saturated zone hydraulic gradient                         | 1.200E-02  | 2.000E-02  |                ---                | HGWT
R014 | Saturated zone b parameter                                | 1.040E+01  | 5.300E+00  |                ---                | BSZ
```

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                                   Site-Specific Parameter Summary (continued)

     |                                                       |   User    |           |        Used by RESRAD          | Parameter
Menu |                   Parameter                           |   Input   |  Default  | (If different from user input) |   Name
-----+-------------------------------------------------------+-----------+-----------+--------------------------------+-------------
R014 | Water table drop rate (m/yr)                          | 0.000E+00 | 1.000E-03 |              ---               | VWT
R014 | Well pump intake depth (m below water table)          | 3.000E+00 | 1.000E+01 |              ---               | DWIBWT
R014 | Model: Nondispersion (ND) or Mass-Balance (MB)        | ND        | ND        |              ---               | MODEL
R014 | Well pumping rate (m**3/yr)                           | 5.000E+01 | 2.500E+02 |              ---               | UW
     |                                                       |           |           |                                |
R015 | Number of unsaturated zone strata                     | 1         | 1         |              ---               | NS
R015 | Unsat. zone 1, thickness (m)                          | 1.000E+00 | 4.000E+00 |              ---               | H(1)
R015 | Unsat. zone 1, soil density (g/cm**3)                 | 1.500E+00 | 1.500E+00 |              ---               | DENSUZ(1)
R015 | Unsat. zone 1, total porosity                         | 3.700E-01 | 4.000E-01 |              ---               | TPUZ(1)
R015 | Unsat. zone 1, effective porosity                     | 1.750E-01 | 2.000E-01 |              ---               | EPUZ(1)
R015 | Unsat. zone 1, soil-specific b parameter              | 1.040E+01 | 5.300E+00 |              ---               | BUZ(1)
R015 | Unsat. zone 1, hydraulic conductivity (m/yr)          | 2.080E+02 | 1.000E+01 |              ---               | HCUZ(1)
     |                                                       |           |           |                                |
R016 | Distribution coefficients for Cs-137                  |           |           |                                |
R016 |   Contaminated zone (cm**3/g)                         | 1.000E+03 | 1.000E+03 |              ---               | DCNUCC( 1)
R016 |   Unsaturated zone 1 (cm**3/g)                        | 1.000E+03 | 1.000E+03 |              ---               | DCNUCU( 1,1)
R016 |   Saturated zone (cm**3/g)                            | 1.000E+03 | 1.000E+03 |              ---               | DCNUCS( 1)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00 |           1.160E-04            | ALEACH( 1)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00 |           not used             | SOLUBK( 1)
     |                                                       |           |           |                                |
R016 | Distribution coefficients for Pb-210                  |           |           |                                |
R016 |   Contaminated zone (cm**3/g)                         | 1.000E+02 | 1.000E+02 |              ---               | DCNUCC( 2)
R016 |   Unsaturated zone 1 (cm**3/g)                        | 1.000E+02 | 1.000E+02 |              ---               | DCNUCU( 2,1)
R016 |   Saturated zone (cm**3/g)                            | 1.000E+02 | 1.000E+02 |              ---               | DCNUCS( 2)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00 |           1.158E-03            | ALEACH( 2)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00 |           not used             | SOLUBK( 2)
     |                                                       |           |           |                                |
R016 | Distribution coefficients for Th-230                  |           |           |                                |
R016 |   Contaminated zone (cm**3/g)                         | 6.000E+04 | 6.000E+04 |              ---               | DCNUCC( 4)
R016 |   Unsaturated zone 1 (cm**3/g)                        | 6.000E+04 | 6.000E+04 |              ---               | DCNUCU( 4,1)
R016 |   Saturated zone (cm**3/g)                            | 6.000E+04 | 6.000E+04 |              ---               | DCNUCS( 4)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00 |           1.933E-06            | ALEACH( 4)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00 |           not used             | SOLUBK( 4)
     |                                                       |           |           |                                |
R016 | Distribution coefficients for U-234                   |           |           |                                |
R016 |   Contaminated zone (cm**3/g)                         | 5.000E+01 | 5.000E+01 |              ---               | DCNUCC( 5)
R016 |   Unsaturated zone 1 (cm**3/g)                        | 5.000E+01 | 5.000E+01 |              ---               | DCNUCU( 5,1)
R016 |   Saturated zone (cm**3/g)                            | 5.000E+01 | 5.000E+01 |              ---               | DCNUCS( 5)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00 |           2.312E-03            | ALEACH( 5)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00 |           not used             | SOLUBK( 5)
     |                                                       |           |           |                                |
R016 | Distribution coefficients for U-238                   |           |           |                                |
R016 |   Contaminated zone (cm**3/g)                         | 5.000E+01 | 5.000E+01 |              ---               | DCNUCC( 6)
R016 |   Unsaturated zone 1 (cm**3/g)                        | 5.000E+01 | 5.000E+01 |              ---               | DCNUCU( 6,1)
R016 |   Saturated zone (cm**3/g)                            | 5.000E+01 | 5.000E+01 |              ---               | DCNUCS( 6)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00 |           2.312E-03            | ALEACH( 6)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00 |           not used             | SOLUBK( 6)
```

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                                   Site-Specific Parameter Summary (continued)

     |                                                    |    User    |            |         Used by RESRAD           |  Parameter
Menu |                      Parameter                     |    Input   |   Default  |  (If different from user input)  |     Name
-----+----------------------------------------------------+------------+------------+----------------------------------+---------------
R016 | Distribution coefficients for daughter Ra-226      |            |            |                                  |
R016 |   Contaminated zone (cm**3/g)                      |  7.000E+01 |  7.000E+01 |               ---                | DCNUCC( 3)
R016 |   Unsaturated zone 1 (cm**3/g)                     |  7.000E+01 |  7.000E+01 |               ---                | DCNUCU( 3,1)
R016 |   Saturated zone (cm**3/g)                         |  7.000E+01 |  7.000E+01 |               ---                | DCNUCS( 3)
R016 |   Leach rate (/yr)                                 |  0.000E+00 |  0.000E+00 |            1.653E-03             | ALEACH( 3)
R016 |   Solubility constant                              |  0.000E+00 |  0.000E+00 |             not used             | SOLUBK( 3)
     |                                                    |            |            |                                  |
R017 | Inhalation rate (m**3/yr)                          |  5.000E+03 |  8.400E+03 |               ---                | INHALR
R017 | Mass loading for inhalation (g/m**3)               |  1.000E-04 |  1.000E-04 |               ---                | MLINH
R017 | Exposure duration                                  |  2.500E+01 |  3.000E+01 |               ---                | ED
R017 | Shielding factor, inhalation                       |  4.000E-01 |  4.000E-01 |               ---                | SHF3
R017 | Shielding factor, external gamma                   |  7.000E-01 |  7.000E-01 |               ---                | SHF1
R017 | Fraction of time spent indoors                     |  4.000E-01 |  5.000E-01 |               ---                | FIND
R017 | Fraction of time spent outdoors (on site)          |  1.000E-01 |  2.500E-01 |               ---                | FOTD
R017 | Shape factor flag, external gamma                  |  1.000E+00 |  1.000E+00 |    >0 shows circular AREA.       | FS
R017 | Radii of shape factor array (used if FS = -1):     |            |            |                                  |
R017 |   Outer annular radius (m), ring  1:               |  not used  |  5.000E+01 |               ---                | RAD SHAPE( 1)
R017 |   Outer annular radius (m), ring  2:               |  not used  |  7.071E+01 |               ---                | RAD SHAPE( 2)
R017 |   Outer annular radius (m), ring  3:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE( 3)
R017 |   Outer annular radius (m), ring  4:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE( 4)
R017 |   Outer annular radius (m), ring  5:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE( 5)
R017 |   Outer annular radius (m), ring  6:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE( 6)
R017 |   Outer annular radius (m), ring  7:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE( 7)
R017 |   Outer annular radius (m), ring  8:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE( 8)
R017 |   Outer annular radius (m), ring  9:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE( 9)
R017 |   Outer annular radius (m), ring 10:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE(10)
R017 |   Outer annular radius (m), ring 11:               |  not used  |  0.000E+00 |               ---                | RAD SHAPE(11)
R017 |   Outer annular radius (m), ring 12:               |  not used  |  0.000E+00 |               ---                | RAD_SHAPE(12)
     |                                                    |            |            |                                  |
R017 | Fractions of annular areas within AREA:            |            |            |                                  |
R017 |   Ring  1                                          |  not used  |  1.000E+00 |               ---                | FRACA( 1)
R017 |   Ring  2                                          |  not used  |  2.732E-01 |               ---                | FRACA( 2)
R017 |   Ring  3                                          |  not used  |  0.000E+00 |               ---                | FRACA( 3)
R017 |   Ring  4                                          |  not used  |  0.000E+00 |               ---                | FRACA( 4)
R017 |   Ring  5                                          |  not used  |  0.000E+00 |               ---                | FRACA( 5)
R017 |   Ring  6                                          |  not used  |  0.000E+00 |               ---                | FRACA( 6)
R017 |   Ring  7                                          |  not used  |  0.000E+00 |               ---                | FRACA( 7)
R017 |   Ring  8                                          |  not used  |  0.000E+00 |               ---                | FRACA( 8)
R017 |   Ring  9                                          |  not used  |  0.000E+00 |               ---                | FRACA( 9)
R017 |   Ring 10                                          |  not used  |  0.000E+00 |               ---                | FRACA(10)
R017 |   Ring 11                                          |  not used  |  0.000E+00 |               ---                | FRACA(11)
R017 |   Ring 12                                          |  not used  |  0.000E+00 |               ---                | FRACA(12)
     |                                                    |            |            |                                  |
R018 | Fruits, vegetables and grain consumption (kg/yr)   |  not used  |  1.600E+02 |               ---                | DIET(1)
R018 | Leafy vegetable consumption (kg/yr)                |  not used  |  1.400E+01 |               ---                | DIET(2)
R018 | Milk consumption (L/yr)                            |  not used  |  9.200E+01 |               ---                | DIET(3)
R018 | Meat and poultry consumption (kg/yr)               |  not used  |  6.300E+01 |               ---                | DIET(4)
R018 | Fish consumption (kg/yr)                           |  not used  |  5.400E+00 |               ---                | DIET(5)
R018 | Other seafood consumption (kg/yr)                  |  not used  |  9.000E-01 |               ---                | DIET(6)
R018 | Soil ingestion rate (g/yr)                         |  1.750E+01 |  3.650E+01 |               ---                | SOIL
R018 | Drinking water intake (L/yr)                       |  1.750E+02 |  5.100E+02 |               ---                | DWI
```

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                              Site-Specific Parameter Summary (continued)

     |                                                 |    User    |             |       Used by RESRAD          |  Parameter
Menu |                   Parameter                     |    Input   |   Default   |  (If different from user input) |    Name
-----|-------------------------------------------------|------------|-------------|---------------------------------|------------
R018 | Contamination fraction of drinking water        | 1.000E+00  | 1.000E+00   |              ---                | FDW
R018 | Contamination fraction of household water       | not used   | 1.000E+00   |              ---                | FHHW
R018 | Contamination fraction of livestock water       | not used   | 1.000E+00   |              ---                | FLW
R018 | Contamination fraction of irrigation water      | not used   | 1.000E+00   |              ---                | FIRW
R018 | Contamination fraction of aquatic food          | not used   | 5.000E-01   |              ---                | FR9
R018 | Contamination fraction of plant food            | not used   |-1           |              ---                | FPLANT
R018 | Contamination fraction of meat                  | not used   |-1           |              ---                | FMEAT
R018 | Contamination fraction of milk                  | not used   |-1           |              ---                | FMILK
     |                                                 |            |             |                                 |
R019 | Livestock fodder intake for meat (kg/day)       | not used   | 6.800E+01   |              ---                | LFI5
R019 | Livestock fodder intake for milk (kg/day)       | not used   | 5.500E+01   |              ---                | LFI6
R019 | Livestock water intake for meat (L/day)         | not used   | 5.000E+01   |              ---                | LWI5
R019 | Livestock water intake for milk (L/day)         | not used   | 1.600E+02   |              ---                | LWI6
R019 | Livestock soil intake (kg/day)                  | not used   | 5.000E-01   |              ---                | LSI
R019 | Mass loading for foliar deposition (g/m**3)     | not used   | 1.000E-04   |              ---                | MLFD
R019 | Depth of soil mixing layer (m)                  | 1.500E-01  | 1.500E-01   |              ---                | DM
R019 | Depth of roots (m)                              | not used   | 9.000E-01   |              ---                | DROOT
R019 | Drinking water fraction from ground water       | 1.000E+00  | 1.000E+00   |              ---                | FGWDW
R019 | Household water fraction from ground water      | 1.000E+00  | 1.000E+00   |              ---                | FGWHH
R019 | Livestock water fraction from ground water      | not used   | 1.000E+00   |              ---                | FGWLW
R019 | Irrigation fraction from ground water           | not used   | 1.000E+00   |              ---                | FGWIR
     |                                                 |            |             |                                 |
R19B | Wet weight crop yield for Non-Leafy (kg/m**2)   | not used   | 7.000E-01   |              ---                | YV(1)
R19B | Wet weight crop yield for Leafy     (kg/m**2)   | not used   | 1.500E+00   |              ---                | YV(2)
R19B | Wet weight crop yield for Fodder    (kg/m**2)   | not used   | 1.100E+00   |              ---                | YV(3)
R19B | Growing Season for  Non-Leafy (years)           | not used   | 1.700E-01   |              ---                | TE(1)
R19B | Growing Season for  Leafy     (years)           | not used   | 2.500E-01   |              ---                | TE(2)
R19B | Growing Season for  Fodder    (years)           | not used   | 8.000E-02   |              ---                | TE(3)
R19B | Translocation Factor for  Non-Leafy             | not used   | 1.000E-01   |              ---                | TIV(1)
R19B | Translocation Factor for  Leafy                 | not used   | 1.000E+00   |              ---                | TIV(2)
R19B | Translocation Factor for  Fodder                | not used   | 1.000E+00   |              ---                | TIV(3)
R19B | Dry Foliar Interception Fraction for  Non-Leafy | not used   | 2.500E-01   |              ---                | RDRY(1)
R19B | Dry Foliar Interception Fraction for  Leafy     | not used   | 2.500E-01   |              ---                | RDRY(2)
R19B | Dry Foliar Interception Fraction for  Fodder    | not used   | 2.500E-01   |              ---                | RDRY(3)
R19B | Wet Foliar Interception Fraction for  Non-Leafy | not used   | 2.500E-01   |              ---                | RWET(1)
R19B | Wet Foliar Interception Fraction for  Leafy     | not used   | 2.500E-01   |              ---                | RWET(2)
R19B | Wet Foliar Interception Fraction for  Fodder    | not used   | 2.500E-01   |              ---                | RWET(3)
R19B | Weathering Removal Constant for Vegetation      | not used   | 2.000E+01   |              ---                | WLAM
     |                                                 |            |             |                                 |
C14  | C-12 concentration in water (g/cm**3)           | not used   | 2.000E-05   |              ---                | C12WTR
C14  | C-12 concentration in contaminated soil (g/g)   | not used   | 3.000E-02   |              ---                | C12CZ
C14  | Fraction of vegetation carbon from soil         | not used   | 2.000E-02   |              ---                | CSOIL
C14  | Fraction of vegetation carbon from air          | not used   | 9.800E-01   |              ---                | CAIR
C14  | C-14 evasion layer thickness in soil (m)        | not used   | 3.000E-01   |              ---                | DMC
C14  | C-14 evasion flux rate from soil (1/sec)        | not used   | 7.000E-07   |              ---                | EVSN
C14  | C-12 evasion flux rate from soil (1/sec)        | not used   | 1.000E-10   |              ---                | REVSN
C14  | Fraction of grain in beef cattle feed           | not used   | 8.000E-01   |              ---                | AVFG4
C14  | Fraction of grain in milk cow feed              | not used   | 2.000E-01   |              ---                | AVFG5
     |                                                 |            |             |                                 |
STOR | Storage times of contaminated foodstuffs (days):|            |             |                                 |
STOR |   Fruits, non-leafy vegetables, and grain       | 1.400E+01  | 1.400E+01   |              ---                | STOR_T(1)
```

```
                                 Site-Specific Parameter Summary (continued)

     |                                                  |    User    |            |       Used by RESRAD          | Parameter
Menu |                 Parameter                        |    Input   |  Default   | (If different from user input)|   Name
-----+--------------------------------------------------+------------+------------+-------------------------------+-----------
STOR |   Leafy vegetables                               | 1.000E+00  | 1.000E+00  |             ---               | STOR_T(2)
STOR |   Milk                                           | 1.000E+00  | 1.000E+00  |             ---               | STOR_T(3)
STOR |   Meat and poultry                               | 2.000E+01  | 2.000E+01  |             ---               | STOR_T(4)
STOR |   Fish                                           | 7.000E+00  | 7.000E+00  |             ---               | STOR_T(5)
STOR |   Crustacea and mollusks                         | 7.000E+00  | 7.000E+00  |             ---               | STOR_T(6)
STOR |   Well water                                     | 1.000E+00  | 1.000E+00  |             ---               | STOR_T(7)
STOR |   Surface water                                  | 1.000E+00  | 1.000E+00  |             ---               | STOR_T(8)
STOR |   Livestock fodder                               | 4.500E+01  | 4.500E+01  |             ---               | STOR_T(9)
     |                                                  |            |            |                               |
R021 | Thickness of building foundation (m)             | not used   | 1.500E-01  |             ---               | FLOOR
R021 | Bulk density of building foundation (g/cm**3)    | not used   | 2.400E+00  |             ---               | DENSFL
R021 | Total porosity of the cover material             | not used   | 4.000E-01  |             ---               | TPCV
R021 | Total porosity of the building foundation        | not used   | 1.000E-01  |             ---               | TPFL
R021 | Volumetric water content of the cover material   | not used   | 5.000E-02  |             ---               | PH2OCV
R021 | Volumetric water content of the foundation       | not used   | 3.000E-02  |             ---               | PH2OFL
R021 | Diffusion coefficient for radon gas (m/sec):     |            |            |                               |
R021 |   in cover material                              | not used   | 2.000E-06  |             ---               | DIFCV
R021 |   in foundation material                         | not used   | 3.000E-07  |             ---               | DIFFL
R021 |   in contaminated zone soil                      | not used   | 2.000E-06  |             ---               | DIFCZ
R021 | Radon vertical dimension of mixing (m)           | not used   | 2.000E+00  |             ---               | HMIX
R021 | Average building air exchange rate (1/hr)        | not used   | 5.000E-01  |             ---               | REXG
R021 | Height of the building (room) (m)                | not used   | 2.500E+00  |             ---               | HRM
R021 | Building interior area factor                    | not used   | 0.000E+00  |             ---               | FAI
R021 | Building depth below ground surface (m)          | not used   |-1.000E+00  |             ---               | DMFL
R021 | Emanating power of Rn-222 gas                    | not used   | 2.500E-01  |             ---               | EMANA(1)
R021 | Emanating power of Rn-220 gas                    | not used   | 1.500E-01  |             ---               | EMANA(2)
=====+==================================================+============+============+===============================+===========


               Summary of Pathway Selections

             Pathway               |  User Selection
-----------------------------------+------------------
   1 -- external gamma             |      active
   2 -- inhalation (w/o radon)     |      active
   3 -- plant ingestion            |    suppressed
   4 -- meat ingestion             |    suppressed
   5 -- milk ingestion             |    suppressed
   6 -- aquatic foods              |    suppressed
   7 -- drinking water             |      active
   8 -- soil ingestion             |      active
   9 -- radon                      |    suppressed
   Find peak pathway doses         |    suppressed
===================================+==================
```

```
     Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g

        Area:  65000.00 square meters                 Cs-137     1.500E+00
   Thickness:      1.00 meters                        Pb-210     9.100E+00
 Cover Depth:      0.00 meters                        Th-230     2.200E+00
                                                      U-234      1.300E+00
                                                      U-238      1.400E+00


                                       Total Dose TDOSE(t), mrem/yr
                                 Basic Radiation Dose Limit =  10 mrem/yr
                 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

   t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
    TDOSE(t):  2.598E+00  2.540E+00  2.321E+00  2.079E+00  1.527E+00  1.167E+00  9.367E-01  7.932E-01
        M(t):  2.598E-01  2.540E-01  2.321E-01  2.079E-01  1.527E-01  1.167E-01  9.367E-02  7.932E-02

Maximum TDOSE(t):  2.598E+00 mrem/yr   at t = 0.000E+00 years
```

```
                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                   Water Independent Pathways (Inhalation excludes radon)

           Ground             Inhalation           Radon               Plant               Meat                Milk                Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  1.879E+00 0.7233  1.108E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.562E-04 0.0003
Pb-210  2.103E-02 0.0081  4.888E-03 0.0019  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.789E-01 0.2228
Th-230  9.975E-04 0.0004  1.660E-02 0.0064  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.055E-02 0.0041
U-234   1.966E-04 0.0001  3.973E-03 0.0015  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.219E-03 0.0012
U-238   7.083E-02 0.0273  3.825E-03 0.0015  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.295E-03 0.0013
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.972E+00 0.7591  2.929E-02 0.0113  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.966E-01 0.2296


                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                  Water Dependent Pathways

           Water               Fish               Radon               Plant               Meat                Milk           All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.880E+00 0.7235
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.048E-01 0.2328
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.815E-02 0.0108
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.389E-03 0.0028
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.795E-02 0.0300
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.598E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                         Water Independent Pathways (Inhalation excludes radon)

          Ground            Inhalation           Radon              Plant              Meat               Milk               Soil
Radio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
=======  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  1.836E+00 0.7230  1.082E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.412E-04 0.0003
Pb-210  2.036E-02 0.0080  4.733E-03 0.0019  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.605E-01 0.2207
Th-230  4.925E-03 0.0019  1.660E-02 0.0065  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.056E-02 0.0042
U-234   1.962E-04 0.0001  3.964E-03 0.0016  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.212E-03 0.0013
U-238   7.066E-02 0.0278  3.816E-03 0.0015  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.288E-03 0.0013
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.932E+00 0.7609  2.912E-02 0.0115  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.782E-01 0.2277

                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                       Water Dependent Pathways

          Water               Fish              Radon              Plant              Meat               Milk          All Pathways*
adio-   ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
uclide   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
=======  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
s-137   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.837E+00 0.7232
b-210   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.856E-01 0.2306
h-230   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.209E-02 0.0126
-234    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.372E-03 0.0029
-238    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.777E-02 0.0306
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
otal    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.540E+00 1.0000

Sum of all water independent and dependent pathways.
```

```
                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                          As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                            Water Independent Pathways (Inhalation excludes radon)

          Ground          Inhalation         Radon            Plant             Meat              Milk              Soil
Radio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
Nuclide mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  1.673E+00 0.7210  9.864E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.843E-04 0.0003
Pb-210  1.790E-02 0.0077  4.160E-03 0.0018  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.927E-01 0.2123
Th-230  2.056E-02 0.0089  1.660E-02 0.0072  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.063E-02 0.0046
U-234   1.946E-04 0.0001  3.928E-03 0.0017  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.182E-03 0.0014
U-238   7.001E-02 0.0302  3.781E-03 0.0016  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.257E-03 0.0014
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.782E+00 0.7678  2.847E-02 0.0123  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.103E-01 0.2199

                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                          As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                              Water Dependent Pathways

          Water           Fish              Radon             Plant             Meat              Milk           All Pathways*
Radio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
Nuclide mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.674E+00 0.7213
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.147E-01 0.2218
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.779E-02 0.0206
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.305E-03 0.0031
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.705E-02 0.0332
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.321E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                   Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                   Water Independent Pathways (Inhalation excludes radon)

              Ground            Inhalation           Radon              Plant              Meat               Milk               Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------
Cs-137  1.490E+00 0.7166  8.783E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.203E-04 0.0003
Pb-210  1.523E-02 0.0073  3.541E-03 0.0017  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.193E-01 0.2017
Th-230  3.991E-02 0.0192  1.661E-02 0.0080  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.074E-02 0.0052
U-234   1.932E-04 0.0001  3.883E-03 0.0019  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.146E-03 0.0015
U-238   6.921E-02 0.0333  3.737E-03 0.0018  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.220E-03 0.0015
======= =========  ======  =========  ======  =========  ======  =========  ======  =========  ======  =========  ======  =========  ======
Total   1.614E+00 0.7765  2.777E-02 0.0134  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.370E-01 0.2102

                   Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                               Water Dependent Pathways

              Water               Fish              Radon              Plant              Meat               Milk          All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.490E+00 0.7168
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.381E-01 0.2107
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.726E-02 0.0323
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.222E-03 0.0035
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.616E-02 0.0366
======= =========  ======  =========  ======  =========  ======  =========  ======  =========  ======  =========  ======  =========  ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.079E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                      Water Independent Pathways (Inhalation excludes radon)

              Ground              Inhalation             Radon                 Plant                 Meat                  Milk                  Soil
Radio-   ------------------    ------------------    ------------------    ------------------    ------------------    ------------------    ------------------
Nuclide  mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------
Cs-137   1.052E+00 0.6885     6.199E-07 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.672E-04 0.0002
Pb-210   9.392E-03 0.0061     2.183E-03 0.0014     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.585E-01 0.1693
Th-230   9.678E-02 0.0634     1.661E-02 0.0109     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.127E-02 0.0074
U-234    1.920E-04 0.0001     3.752E-03 0.0025     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.040E-03 0.0020
U-238    6.685E-02 0.0438     3.610E-03 0.0024     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.110E-03 0.0020
=======  =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======
Total    1.225E+00 0.8020     2.615E-02 0.0171     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.763E-01 0.1809


                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                    Water Dependent Pathways

              Water                 Fish                 Radon                 Plant                 Meat                  Milk             All Pathways*
Radio-   ------------------    ------------------    ------------------    ------------------    ------------------    ------------------    ------------------
Nuclide  mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------
Cs-137   0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.052E+00 0.6888
Pb-210   0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.701E-01 0.1769
Th-230   0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.247E-01 0.0816
U-234    0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     6.983E-03 0.0046
U-238    0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.357E-02 0.0482
=======  =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======
Total    0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.527E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                 Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                    Water Independent Pathways (Inhalation excludes radon)

           Ground              Inhalation            Radon                Plant                Meat                 Milk                 Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137  7.423E-01 0.6359    4.376E-07 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.592E-04 0.0002
Pb-210  5.791E-03 0.0050    1.346E-03 0.0012    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.594E-01 0.1365
Th-230  1.519E-01 0.1301    1.661E-02 0.0142    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.196E-02 0.0102
U-234   1.952E-04 0.0002    3.625E-03 0.0031    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.937E-03 0.0025
U-238   6.457E-02 0.0553    3.487E-03 0.0030    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.005E-03 0.0026
======= =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total   9.648E-01 0.8264    2.507E-02 0.0215    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.776E-01 0.1521


                 Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                                Water Dependent Pathways

           Water               Fish                 Radon                Plant                Meat                 Milk             All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.426E-01 0.6361
Pb-210  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.665E-01 0.1427
Th-230  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.805E-01 0.1546
U-234   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.757E-03 0.0058
U-238   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.106E-02 0.0609
======= =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.167E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                           Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                           As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                    Water Independent Pathways (Inhalation excludes radon)

             Ground              Inhalation            Radon                 Plant                 Meat                  Milk                  Soil
Radio-   -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
Cs-137   5.240E-01 0.5594  3.089E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.830E-04 0.0002
Pb-210   3.570E-03 0.0038  8.299E-04 0.0009  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.828E-02 0.1049
Th-230   2.053E-01 0.2192  1.662E-02 0.0177  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.276E-02 0.0136
U-234    2.026E-04 0.0002  3.502E-03 0.0037  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.837E-03 0.0030
U-238    6.237E-02 0.0666  3.369E-03 0.0036  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.902E-03 0.0031
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    7.954E-01 0.8492  2.432E-02 0.0260  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.170E-01 0.1249

                           Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                           As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                                Water Dependent Pathways

             Water               Fish                  Radon                 Plant                 Meat                  Milk              All Pathways*
Radio-   -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
Cs-137   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.242E-01 0.5596
Pb-210   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.027E-01 0.1096
Th-230   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.347E-01 0.2505
U-234    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.542E-03 0.0070
U-238    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.864E-02 0.0733
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.367E-01 1.0000

*Sum of all water independent and dependent pathways.
```

```
                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                           Water Independent Pathways (Inhalation excludes radon)

              Ground            Inhalation            Radon               Plant               Meat                Milk                Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------
Cs-137  3.699E-01 0.4663    2.180E-07 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.292E-04 0.0002
Pb-210  2.201E-03 0.0028    5.116E-04 0.0006    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.060E-02 0.0764
Th-230  2.571E-01 0.3241    1.662E-02 0.0210    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.360E-02 0.0171
U-234   2.138E-04 0.0003    3.384E-03 0.0043    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.742E-03 0.0035
U-238   6.024E-02 0.0759    3.254E-03 0.0041    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.803E-03 0.0035
======= ========== ======   ========== ======   ========== ======   ========== ======   ========== ======   ========== ======   ========== ======
Total   6.896E-01 0.8693    2.377E-02 0.0300    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.987E-02 0.1007


                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                    Water Dependent Pathways

              Water               Fish                Radon               Plant               Meat                Milk            All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------
Cs-137  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.700E-01 0.4664
Pb-210  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.331E-02 0.0798
Th-230  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.873E-01 0.3622
U-234   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.340E-03 0.0080
U-238   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.630E-02 0.0836
======= ========== ======   ========== ======   ========== ======   ========== ======   ========== ======   ========== ======   ========== ======
Total   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.932E-01 1.0000
*Sum of all water independent and dependent pathways.
```

```
                                 Dose/Source Ratios Summed Over All Pathways
                       Parent and Progeny Principal Radionuclide Contributions Indicated

Parent    Product  Branch                              DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)        (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
---------  --------  ---------    --------- --------- --------- --------- --------- --------- --------- ---------
Cs-137    Cs-137   1.000E+00     1.253E+00 1.224E+00 1.116E+00 9.935E-01 7.013E-01 4.950E-01 3.494E-01 2.467E-01

Pb-210    Pb-210   1.000E+00     6.646E-02 6.435E-02 5.657E-02 4.814E-02 2.968E-02 1.830E-02 1.128E-02 6.957E-03

Th-230    Th-230   1.000E+00     1.280E-02 1.280E-02 1.280E-02 1.279E-02 1.279E-02 1.279E-02 1.279E-02 1.279E-02
Th-230    Ra-226   1.000E+00     0.000E+00 1.790E-03 8.915E-03 1.774E-02 4.365E-02 6.877E-02 9.311E-02 1.167E-01
Th-230    Pb-210   1.000E+00     0.000E+00 4.424E-07 1.057E-05 4.001E-05 2.135E-04 4.718E-04 7.777E-04 1.108E-03
Th-230    ∑DSR(j)                1.280E-02 1.459E-02 2.172E-02 3.057E-02 5.666E-02 8.203E-02 1.067E-01 1.306E-01

U-234     U-234    1.000E+00     5.684E-03 5.670E-03 5.618E-03 5.553E-03 5.364E-03 5.181E-03 5.004E-03 4.833E-03
U-234     Th-230   1.000E+00     0.000E+00 1.151E-07 5.726E-07 1.139E-06 2.798E-06 4.400E-06 5.947E-06 7.441E-06
U-234     Ra-226   1.000E+00     0.000E+00 8.056E-09 2.002E-07 7.950E-07 4.860E-06 1.217E-05 2.252E-05 3.569E-05
U-234     Pb-210   1.000E+00     0.000E+00 1.330E-12 1.604E-10 1.227E-09 1.686E-08 6.117E-08 1.417E-07 2.620E-07
U-234     ∑DSR(j)                5.684E-03 5.670E-03 5.619E-03 5.555E-03 5.372E-03 5.197E-03 5.033E-03 4.877E-03

U-238     U-238    1.000E+00     5.568E-02 5.555E-02 5.504E-02 5.440E-02 5.255E-02 5.076E-02 4.903E-02 4.736E-02
U-238     U-234    1.000E+00     0.000E+00 1.608E-08 7.964E-08 1.574E-07 3.802E-07 5.875E-07 7.803E-07 9.592E-07
U-238     Th-230   1.000E+00     0.000E+00 1.630E-13 4.050E-12 1.608E-11 9.819E-11 2.456E-10 4.538E-10 7.185E-10
U-238     Ra-226   1.000E+00     0.000E+00 7.612E-15 9.450E-13 7.497E-12 1.142E-10 4.562E-10 1.157E-09 2.326E-09
U-238     Pb-210   1.000E+00     0.000E+00 9.595E-19 5.722E-16 8.814E-15 3.082E-13 1.817E-12 5.871E-12 1.398E-11
U-238     ∑DSR(j)                5.568E-02 5.555E-02 5.504E-02 5.440E-02 5.255E-02 5.076E-02 4.903E-02 4.736E-02
=========  ========  =========    ========= ========= ========= ========= ========= ========= ========= =========
*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.


                       Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                            Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)     t= 0.000E+00    1.000E+00    5.000E+00    1.000E+01    2.500E+01    4.000E+01    5.500E+01    7.000E+01
-------      ---------    ---------    ---------    ---------    ---------    ---------    ---------    ---------
Cs-137       7.979E+00    8.167E+00    8.962E+00    1.006E+01    1.426E+01    2.020E+01    2.862E+01    4.054E+01
Pb-210       1.505E+02    1.554E+02    1.768E+02    2.077E+02    3.369E+02    5.464E+02    8.862E+02    1.437E+03
Th-230       7.815E+02    6.856E+02    4.604E+02    3.271E+02    1.765E+02    1.219E+02    9.375E+01    7.658E+01
U-234        1.759E+03    1.764E+03    1.780E+03    1.800E+03    1.862E+03    1.924E+03    1.987E+03    2.051E+03
U-238        1.796E+02    1.800E+02    1.817E+02    1.838E+02    1.903E+02    1.970E+02    2.040E+02    2.112E+02
=======      =========    =========    =========    =========    =========    =========    =========    =========
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            Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
            and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
         at tmin = time of minimum single radionuclide soil guideline
     and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide  Initial          tmin        DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
  (i)     pCi/g          (years)                   (pCi/g)               (pCi/g)
_______ _________  ________________  _________  _________  _________  _________

Cs-137  1.500E+00     0.000E+00       1.253E+00  7.979E+00  1.253E+00  7.979E+00
Pb-210  9.100E+00     0.000E+00       6.646E-02  1.505E+02  6.646E-02  1.505E+02
Th-230  2.200E+00     7.000E+01       1.306E-01  7.658E+01  1.280E-02  7.815E+02
U-234   1.300E+00     0.000E+00       5.684E-03  1.759E+03  5.684E-03  1.759E+03
U-238   1.400E+00     0.000E+00       5.568E-02  1.796E+02  5.568E-02  1.796E+02
=======  =========  ================  =========  =========  =========  =========
```

```
                                      Individual Nuclide Dose Summed Over All Pathways
                                        Parent Nuclide and Branch Fraction Indicated

Nuclide  Parent    BRF(i)                                                 DOSE(j,t), mrem/yr
  (j)      (i)                 t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
-------  -------  ---------       --------- --------- --------- --------- --------- --------- --------- ---------
Cs-137   Cs-137   1.000E+00       1.880E+00 1.837E+00 1.674E+00 1.490E+00 1.052E+00 7.426E-01 5.242E-01 3.700E-01

Pb-210   Pb-210   1.000E+00       6.048E-01 5.856E-01 5.147E-01 4.381E-01 2.701E-01 1.665E-01 1.027E-01 6.331E-02
Pb-210   Th-230   1.000E+00       0.000E+00 9.732E-07 2.326E-05 8.803E-05 4.698E-04 1.038E-03 1.711E-03 2.438E-03
Pb-210   U-234    1.000E+00       0.000E+00 1.730E-12 2.085E-10 1.595E-09 2.192E-08 7.952E-08 1.843E-07 3.406E-07
Pb-210   U-238    1.000E+00       0.000E+00 1.343E-18 8.010E-16 1.234E-14 4.315E-13 2.544E-12 8.220E-12 1.957E-11
Pb-210   ∑DOSE(j):                6.048E-01 5.856E-01 5.148E-01 4.382E-01 2.706E-01 1.676E-01 1.044E-01 6.575E-02

Th-230   Th-230   1.000E+00       2.815E-02 2.815E-02 2.815E-02 2.815E-02 2.814E-02 2.814E-02 2.813E-02 2.813E-02
Th-230   U-234    1.000E+00       0.000E+00 1.496E-07 7.444E-07 1.480E-06 3.637E-06 5.719E-06 7.731E-06 9.673E-06
Th-230   U-238    1.000E+00       0.000E+00 2.282E-13 5.671E-12 2.251E-11 1.375E-10 3.439E-10 6.354E-10 1.006E-09
Th-230   ∑DOSE(j):                2.815E-02 2.815E-02 2.815E-02 2.815E-02 2.815E-02 2.814E-02 2.814E-02 2.814E-02

Ra-226   Th-230   1.000E+00       0.000E+00 3.939E-03 1.961E-02 3.902E-02 9.604E-02 1.513E-01 2.048E-01 2.567E-01
Ra-226   U-234    1.000E+00       0.000E+00 1.047E-08 2.603E-07 1.033E-06 6.319E-06 1.582E-05 2.927E-05 4.639E-05
Ra-226   U-238    1.000E+00       0.000E+00 1.066E-14 1.323E-12 1.050E-11 1.599E-10 6.387E-10 1.619E-09 3.256E-09
Ra-226   ∑DOSE(j):                0.000E+00 3.939E-03 1.961E-02 3.902E-02 9.605E-02 1.513E-01 2.049E-01 2.568E-01

U-234    U-234    1.000E+00       7.389E-03 7.371E-03 7.304E-03 7.219E-03 6.973E-03 6.735E-03 6.505E-03 6.283E-03
U-234    U-238    1.000E+00       0.000E+00 2.251E-08 1.115E-07 2.204E-07 5.322E-07 8.225E-07 1.092E-06 1.343E-06
U-234    ∑DOSE(j):                7.389E-03 7.372E-03 7.304E-03 7.220E-03 6.974E-03 6.736E-03 6.506E-03 6.285E-03

U-238    U-238    1.000E+00       7.795E-02 7.777E-02 7.705E-02 7.616E-02 7.357E-02 7.106E-02 6.864E-02 6.630E-02
=======  =======  =========       ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
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                                       Individual Nuclide Soil Concentration
                                    Parent Nuclide and Branch Fraction Indicated

Nuclide  Parent    BRF(i)                                            S(j,t), pCi/g
  (j)     (i)               t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______  _______  _________    _________ _________ _________ _________ _________ _________ _________ _________

Cs-137   Cs-137   1.000E+00    1.500E+00 1.466E+00 1.336E+00 1.189E+00 8.394E-01 5.925E-01 4.182E-01 2.952E-01

Pb-210   Pb-210   1.000E+00    9.100E+00 8.811E+00 7.745E+00 6.592E+00 4.064E+00 2.506E+00 1.545E+00 9.526E-01
Pb-210   Th-230   1.000E+00    0.000E+00 1.464E-05 3.499E-04 1.325E-03 7.068E-03 1.562E-02 2.574E-02 3.669E-02
Pb-210   U-234    1.000E+00    0.000E+00 2.602E-11 3.137E-09 2.401E-08 3.299E-07 1.197E-06 2.772E-06 5.125E-06
Pb-210   U-238    1.000E+00    0.000E+00 2.021E-17 1.205E-14 1.857E-13 6.493E-12 3.828E-11 1.237E-10 2.945E-10
Pb-210   ∑S(j):                9.100E+00 8.811E+00 7.746E+00 6.593E+00 4.071E+00 2.521E+00 1.571E+00 9.893E-01

Th-230   Th-230   1.000E+00    2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00 2.198E+00
Th-230   U-234    1.000E+00    0.000E+00 1.169E-05 5.817E-05 1.157E-04 2.842E-04 4.470E-04 6.042E-04 7.559E-04
Th-230   U-238    1.000E+00    0.000E+00 1.784E-11 4.432E-10 1.759E-09 1.074E-08 2.687E-08 4.966E-08 7.861E-08
Th-230   ∑S(j):                2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00

Ra-226   Th-230   1.000E+00    0.000E+00 9.521E-04 4.740E-03 9.432E-03 2.321E-02 3.657E-02 4.951E-02 6.205E-02
Ra-226   U-234    1.000E+00    0.000E+00 2.531E-09 6.291E-08 2.498E-07 1.527E-06 3.825E-06 7.075E-06 1.121E-05
Ra-226   U-238    1.000E+00    0.000E+00 2.576E-15 3.198E-13 2.537E-12 3.865E-11 1.544E-10 3.914E-10 7.870E-10
Ra-226   ∑S(j):                0.000E+00 9.521E-04 4.741E-03 9.432E-03 2.321E-02 3.657E-02 4.952E-02 6.206E-02

U-234    U-234    1.000E+00    1.300E+00 1.297E+00 1.285E+00 1.270E+00 1.227E+00 1.185E+00 1.145E+00 1.106E+00
U-234    U-238    1.000E+00    0.000E+00 3.960E-06 1.962E-05 3.878E-05 9.365E-05 1.447E-04 1.922E-04 2.363E-04
U-234    ∑S(j):                1.300E+00 1.297E+00 1.285E+00 1.270E+00 1.227E+00 1.185E+00 1.145E+00 1.106E+00

U-238    U-238    1.000E+00    1.400E+00 1.397E+00 1.384E+00 1.368E+00 1.321E+00 1.276E+00 1.233E+00 1.191E+00
=======  =======  =========    ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
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RESRAD OUTPUT FOR RECREATIONAL CHILD – SEDIMENT SUPPORT FOR COMPLIANCE WITH NYSDEC TAGM

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

```
                      Dose Conversion Factor (and Related) Parameter Summary
                                        File: DOSFAC.BIN

     |                                                    |  Current  |           | Parameter
Menu |                      Parameter                     |   Value   |  Default  |   Name
-----+----------------------------------------------------+-----------+-----------+--------------
B-1  | Dose conversion factors for inhalation, mrem/pCi:  |           |           |
B-1  | Cs-137+D                                           | 3.190E-05 | 3.190E-05 | DCF2( 1)
B-1  | Pb-210+D                                           | 2.320E-02 | 2.320E-02 | DCF2( 2)
B-1  | Ra-226+D                                           | 8.600E-03 | 8.600E-03 | DCF2( 3)
B-1  | Th-230                                             | 3.260E-01 | 3.260E-01 | DCF2( 4)
B-1  | U-234                                              | 1.320E-01 | 1.320E-01 | DCF2( 5)
B-1  | U-238+D                                            | 1.180E-01 | 1.180E-01 | DCF2( 6)
     |                                                    |           |           |
D-1  | Dose conversion factors for ingestion, mrem/pCi:   |           |           |
D-1  | Cs-137+D                                           | 5.000E-05 | 5.000E-05 | DCF3( 1)
D-1  | Pb-210+D                                           | 7.270E-03 | 7.270E-03 | DCF3( 2)
D-1  | Ra-226+D                                           | 1.330E-03 | 1.330E-03 | DCF3( 3)
D-1  | Th-230                                             | 5.480E-04 | 5.480E-04 | DCF3( 4)
D-1  | U-234                                              | 2.830E-04 | 2.830E-04 | DCF3( 5)
D-1  | U-238+D                                            | 2.690E-04 | 2.690E-04 | DCF3( 6)
     |                                                    |           |           |
D-34 | Food transfer factors:                             |           |           |
D-34 | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 1,1)
D-34 | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 1,2)
D-34 | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 8.000E-03 | 8.000E-03 | RTF( 1,3)
D-34 |                                                    |           |           |
D-34 | Pb-210+D , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 2,1)
D-34 | Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04 | 8.000E-04 | RTF( 2,2)
D-34 | Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 3.000E-04 | 3.000E-04 | RTF( 2,3)
D-34 |                                                    |           |           |
D-34 | Ra-226+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 3,1)
D-34 | Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF( 3,2)
D-34 | Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03 | 1.000E-03 | RTF( 3,3)
D-34 |                                                    |           |           |
D-34 | Th-230   , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 4,1)
D-34 | Th-230   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 4,2)
D-34 | Th-230   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF( 4,3)
D-34 |                                                    |           |           |
D-34 | U-234    , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 5,1)
D-34 | U-234    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 5,2)
D-34 | U-234    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF( 5,3)
D-34 |                                                    |           |           |
D-34 | U-238+D  , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 6,1)
D-34 | U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 6,2)
D-34 | U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF( 6,3)
     |                                                    |           |           |
D-5  | Bioaccumulation factors, fresh water, L/kg:        |           |           |
D-5  | Cs-137+D , fish                                    | 2.000E+03 | 2.000E+03 | BIOFAC( 1,1)
D-5  | Cs-137+D , crustacea and mollusks                  | 1.000E+02 | 1.000E+02 | BIOFAC( 1,2)
D-5  |                                                    |           |           |
D-5  | Pb-210+D , fish                                    | 3.000E+02 | 3.000E+02 | BIOFAC( 2,1)
D-5  | Pb-210+D , crustacea and mollusks                  | 1.000E+02 | 1.000E+02 | BIOFAC( 2,2)
D-5  |                                                    |           |           |
D-5  | Ra-226+D , fish                                    | 5.000E+01 | 5.000E+01 | BIOFAC( 3,1)
D-5  | Ra-226+D , crustacea and mollusks                  | 2.500E+02 | 2.500E+02 | BIOFAC( 3,2)
```

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(4,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(5,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(5,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)

```
                                        Site-Specific Parameter Summary

     |                                                   |    User     |             |          Used by RESRAD          | Parameter
Menu |                    Parameter                      |    Input    |   Default   | (If different from user input)  |   Name
-----+---------------------------------------------------+-------------+-------------+---------------------------------+----------
R011 | Area of contaminated zone (m**2)                  |  6.500E+04  |  1.000E+04  |               ---               | AREA
R011 | Thickness of contaminated zone (m)                |  1.000E+00  |  2.000E+00  |               ---               | THICK0
R011 | Length parallel to aquifer flow (m)               |  2.170E+02  |  1.000E+02  |               ---               | LCZPAQ
R011 | Basic radiation dose limit (mrem/yr)              |  1.000E+01  |  3.000E+01  |               ---               | BRDL
R011 | Time since placement of material (yr)             |  0.000E+00  |  0.000E+00  |               ---               | TI
R011 | Times for calculations (yr)                       |  1.000E+00  |  1.000E+00  |               ---               | T( 2)
R011 | Times for calculations (yr)                       |  5.000E+00  |  3.000E+00  |               ---               | T( 3)
R011 | Times for calculations (yr)                       |  1.000E+01  |  1.000E+01  |               ---               | T( 4)
R011 | Times for calculations (yr)                       |  2.500E+01  |  3.000E+01  |               ---               | T( 5)
R011 | Times for calculations (yr)                       |  4.000E+01  |  1.000E+02  |               ---               | T( 6)
R011 | Times for calculations (yr)                       |  5.500E+01  |  3.000E+02  |               ---               | T( 7)
R011 | Times for calculations (yr)                       |  7.000E+01  |  1.000E+03  |               ---               | T( 8)
R011 | Times for calculations (yr)                       |  not used   |  0.000E+00  |               ---               | T( 9)
R011 | Times for calculations (yr)                       |  not used   |  0.000E+00  |               ---               | T(10)
     |                                                   |             |             |                                 |
R012 | Initial principal radionuclide (pCi/g):  Cs-137   |  1.500E+00  |  0.000E+00  |               ---               | S1( 1)
R012 | Initial principal radionuclide (pCi/g):  Pb-210   |  9.100E+00  |  0.000E+00  |               ---               | S1( 2)
R012 | Initial principal radionuclide (pCi/g):  Th-230   |  2.200E+00  |  0.000E+00  |               ---               | S1( 4)
R012 | Initial principal radionuclide (pCi/g):  U-234    |  1.300E+00  |  0.000E+00  |               ---               | S1( 5)
R012 | Initial principal radionuclide (pCi/g):  U-238    |  1.400E+00  |  0.000E+00  |               ---               | S1( 6)
R012 | Concentration in groundwater   (pCi/L):  Cs-137   |  not used   |  0.000E+00  |               ---               | W1( 1)
R012 | Concentration in groundwater   (pCi/L):  Pb-210   |  not used   |  0.000E+00  |               ---               | W1( 2)
R012 | Concentration in groundwater   (pCi/L):  Th-230   |  not used   |  0.000E+00  |               ---               | W1( 4)
R012 | Concentration in groundwater   (pCi/L):  U-234    |  not used   |  0.000E+00  |               ---               | W1( 5)
R012 | Concentration in groundwater   (pCi/L):  U-238    |  not used   |  0.000E+00  |               ---               | W1( 6)
     |                                                   |             |             |                                 |
R013 | Cover depth (m)                                   |  0.000E+00  |  0.000E+00  |               ---               | COVER0
R013 | Density of cover material (g/cm**3)               |  not used   |  1.500E+00  |               ---               | DENSCV
R013 | Cover depth erosion rate (m/yr)                   |  not used   |  1.000E-03  |               ---               | VCV
R013 | Density of contaminated zone (g/cm**3)            |  1.500E+00  |  1.500E+00  |               ---               | DENSCZ
R013 | Contaminated zone erosion rate (m/yr)             |  6.000E-05  |  1.000E-03  |               ---               | VCZ
R013 | Contaminated zone total porosity                  |  3.700E-01  |  4.000E-01  |               ---               | TPCZ
R013 | Contaminated zone effective porosity              |  1.750E-01  |  2.000E-01  |               ---               | EPCZ
R013 | Contaminated zone hydraulic conductivity (m/yr)   |  2.080E+02  |  1.000E+01  |               ---               | HCCZ
R013 | Contaminated zone b parameter                     |  7.750E+00  |  5.300E+00  |               ---               | BCZ
     | Average annual wind speed (m/sec)                 |  3.000E+00  |  2.000E+00  |               ---               | WIND
     | Humidity in air (g/m**3)                          |  not used   |  8.000E+00  |               ---               | HUMID
R013 | Evapotranspiration coefficient                    |  7.100E-01  |  5.000E-01  |               ---               | EVAPTR
R013 | Precipitation (m/yr)                              |  7.500E-01  |  1.000E+00  |               ---               | PRECIP
R013 | Irrigation (m/yr)                                 |  0.000E+00  |  2.000E-01  |               ---               | RI
R013 | Irrigation mode                                   |  overhead   |  overhead   |               ---               | IDITCH
R013 | Runoff coefficient                                |  2.000E-01  |  2.000E-01  |               ---               | RUNOFF
R013 | Watershed area for nearby stream or pond (m**2)   |  1.300E+07  |  1.000E+06  |               ---               | WAREA
R013 | Accuracy for water/soil computations              |  1.000E-03  |  1.000E-03  |               ---               | EPS
     |                                                   |             |             |                                 |
R014 | Density of saturated zone (g/cm**3)               |  1.500E+00  |  1.500E+00  |               ---               | DENSAQ
R014 | Saturated zone total porosity                     |  3.700E-01  |  4.000E-01  |               ---               | TPSZ
R014 | Saturated zone effective porosity                 |  1.750E-01  |  2.000E-01  |               ---               | EPSZ
R014 | Saturated zone hydraulic conductivity (m/yr)      |  2.080E+02  |  1.000E+02  |               ---               | HCSZ
R014 | Saturated zone hydraulic gradient                 |  1.200E-02  |  2.000E-02  |               ---               | HGWT
```

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                                   Site-Specific Parameter Summary (continued)

     |                                                    |   User     |            |        Used by RESRAD             | Parameter
Menu |                     Parameter                      |   Input    |  Default   | (If different from user input)    |   Name
-----+----------------------------------------------------+------------+------------+-----------------------------------+--------------
R014 | Saturated zone b parameter                         | 1.040E+01  | 5.300E+00  |              ---                  | BSZ
R014 | Water table drop rate (m/yr)                       | 0.000E+00  | 1.000E-03  |              ---                  | VWT
R014 | Well pump intake depth (m below water table)       | 3.000E+00  | 1.000E+01  |              ---                  | DWIBWT
R014 | Model: Nondispersion (ND) or Mass-Balance (MB)     | ND         | ND         |              ---                  | MODEL
R014 | Well pumping rate (m**3/yr)                        | 5.000E+01  | 2.500E+02  |              ---                  | UW
     |                                                    |            |            |                                   |
R015 | Number of unsaturated zone strata                  | 1          | 1          |              ---                  | NS
R015 | Unsat. zone 1, thickness (m)                       | 1.000E+00  | 4.000E+00  |              ---                  | H(1)
R015 | Unsat. zone 1, soil density (g/cm**3)              | 1.500E+00  | 1.500E+00  |              ---                  | DENSUZ(1)
R015 | Unsat. zone 1, total porosity                      | 3.700E-01  | 4.000E-01  |              ---                  | TPUZ(1)
R015 | Unsat. zone 1, effective porosity                  | 1.750E-01  | 2.000E-01  |              ---                  | EPUZ(1)
R015 | Unsat. zone 1, soil-specific b parameter           | 7.750E+00  | 5.300E+00  |              ---                  | BUZ(1)
R015 | Unsat. zone 1, hydraulic conductivity (m/yr)       | 2.080E+02  | 1.000E+01  |              ---                  | HCUZ(1)
     |                                                    |            |            |                                   |
R016 | Distribution coefficients for Cs-137               |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)                      | 1.000E+03  | 1.000E+03  |              ---                  | DCNUCC( 1)
R016 |   Unsaturated zone 1 (cm**3/g)                     | 1.000E+03  | 1.000E+03  |              ---                  | DCNUCU( 1,1)
R016 |   Saturated zone (cm**3/g)                         | 1.000E+03  | 1.000E+03  |              ---                  | DCNUCS( 1)
R016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |           1.160E-04               | ALEACH( 1)
R016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |           not used                | SOLUBK( 1)
     |                                                    |            |            |                                   |
R016 | Distribution coefficients for Pb-210               |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)                      | 1.000E+02  | 1.000E+02  |              ---                  | DCNUCC( 2)
R016 |   Unsaturated zone 1 (cm**3/g)                     | 1.000E+02  | 1.000E+02  |              ---                  | DCNUCU( 2,1)
R016 |   Saturated zone (cm**3/g)                         | 1.000E+02  | 1.000E+02  |              ---                  | DCNUCS( 2)
R016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |           1.158E-03               | ALEACH( 2)
R016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |           not used                | SOLUBK( 2)
     |                                                    |            |            |                                   |
R016 | Distribution coefficients for Th-230               |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)                      | 6.000E+04  | 6.000E+04  |              ---                  | DCNUCC( 4)
R016 |   Unsaturated zone 1 (cm**3/g)                     | 6.000E+04  | 6.000E+04  |              ---                  | DCNUCU( 4,1)
R016 |   Saturated zone (cm**3/g)                         | 6.000E+04  | 6.000E+04  |              ---                  | DCNUCS( 4)
R016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |           1.933E-06               | ALEACH( 4)
R016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |           not used                | SOLUBK( 4)
     |                                                    |            |            |                                   |
 016 | Distribution coefficients for U-234                |            |            |                                   |
 016 |   Contaminated zone (cm**3/g)                      | 5.000E+01  | 5.000E+01  |              ---                  | DCNUCC( 5)
 016 |   Unsaturated zone 1 (cm**3/g)                     | 5.000E+01  | 5.000E+01  |              ---                  | DCNUCU( 5,1)
 016 |   Saturated zone (cm**3/g)                         | 5.000E+01  | 5.000E+01  |              ---                  | DCNUCS( 5)
 016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |           2.312E-03               | ALEACH( 5)
 016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |           not used                | SOLUBK( 5)
     |                                                    |            |            |                                   |
 016 | Distribution coefficients for U-238                |            |            |                                   |
 016 |   Contaminated zone (cm**3/g)                      | 5.000E+01  | 5.000E+01  |              ---                  | DCNUCC( 6)
 016 |   Unsaturated zone 1 (cm**3/g)                     | 5.000E+01  | 5.000E+01  |              ---                  | DCNUCU( 6,1)
 016 |   Saturated zone (cm**3/g)                         | 5.000E+01  | 5.000E+01  |              ---                  | DCNUCS( 6)
 016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |           2.312E-03               | ALEACH( 6)
 016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |           not used                | SOLUBK( 6)
```

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                                               Site-Specific Parameter Summary (continued)

     |                                                     |    User     |             |        Used by RESRAD              |  Parameter
Menu |                      Parameter                      |    Input    |   Default   | (If different from user input)     |   Name
-----+-----------------------------------------------------+-------------+-------------+------------------------------------+---------------
R016 | Distribution coefficients for daughter Ra-226       |             |             |                                    |
R016 |   Contaminated zone (cm**3/g)                       |  7.000E+01  |  7.000E+01  |               ---                  | DCNUCC( 3)
R016 |   Unsaturated zone 1 (cm**3/g)                      |  7.000E+01  |  7.000E+01  |               ---                  | DCNUCU( 3,1)
R016 |   Saturated zone (cm**3/g)                          |  7.000E+01  |  7.000E+01  |               ---                  | DCNUCS( 3)
R016 |   Leach rate (/yr)                                  |  0.000E+00  |  0.000E+00  |            1.653E-03               | ALEACH( 3)
R016 |   Solubility constant                               |  0.000E+00  |  0.000E+00  |            not used                | SOLUBK( 3)
     |                                                     |             |             |                                    |
R017 | Inhalation rate (m**3/yr)                           |  1.220E+02  |  8.400E+03  |               ---                  | INHALR
R017 | Mass loading for inhalation (g/m**3)                |  1.000E-04  |  1.000E-04  |               ---                  | MLINH
R017 | Exposure duration                                   |  5.000E+00  |  3.000E+01  |               ---                  | ED
R017 | Shielding factor, inhalation                        |  4.000E-01  |  4.000E-01  |               ---                  | SHF3
R017 | Shielding factor, external gamma                    |  7.000E-01  |  7.000E-01  |               ---                  | SHF1
R017 | Fraction of time spent indoors                      |  0.000E+00  |  5.000E-01  |               ---                  | FIND
R017 | Fraction of time spent outdoors (on site)           |  3.300E-01  |  2.500E-01  |               ---                  | FOTD
R017 | Shape factor flag, external gamma                   |  1.000E+00  |  1.000E+00  |   >0 shows circular AREA.          | FS
R017 | Radii of shape factor array (used if FS = -1):      |             |             |                                    |
R017 |   Outer annular radius (m), ring  1:                |  not used   |  5.000E+01  |               ---                  | RAD SHAPE( 1)
R017 |   Outer annular radius (m), ring  2:                |  not used   |  7.071E+01  |               ---                  | RAD SHAPE( 2)
R017 |   Outer annular radius (m), ring  3:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE( 3)
R017 |   Outer annular radius (m), ring  4:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE( 4)
R017 |   Outer annular radius (m), ring  5:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE( 5)
R017 |   Outer annular radius (m), ring  6:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE( 6)
R017 |   Outer annular radius (m), ring  7:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE( 7)
R017 |   Outer annular radius (m), ring  8:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE( 8)
R017 |   Outer annular radius (m), ring  9:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE( 9)
R017 |   Outer annular radius (m), ring 10:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE(10)
R017 |   Outer annular radius (m), ring 11:                |  not used   |  0.000E+00  |               ---                  | RAD SHAPE(11)
R017 |   Outer annular radius (m), ring 12:                |  not used   |  0.000E+00  |               ---                  | RAD_SHAPE(12)
     |                                                     |             |             |                                    |
R017 | Fractions of annular areas within AREA:             |             |             |                                    |
R017 |   Ring  1                                           |  not used   |  1.000E+00  |               ---                  | FRACA( 1)
R017 |   Ring  2                                           |  not used   |  2.732E-01  |               ---                  | FRACA( 2)
R017 |   Ring  3                                           |  not used   |  0.000E+00  |               ---                  | FRACA( 3)
R017 |   Ring  4                                           |  not used   |  0.000E+00  |               ---                  | FRACA( 4)
R017 |   Ring  5                                           |  not used   |  0.000E+00  |               ---                  | FRACA( 5)
R017 |   Ring  6                                           |  not used   |  0.000E+00  |               ---                  | FRACA( 6)
R017 |   Ring  7                                           |  not used   |  0.000E+00  |               ---                  | FRACA( 7)
R017 |   Ring  8                                           |  not used   |  0.000E+00  |               ---                  | FRACA( 8)
R017 |   Ring  9                                           |  not used   |  0.000E+00  |               ---                  | FRACA( 9)
R017 |   Ring 10                                           |  not used   |  0.000E+00  |               ---                  | FRACA(10)
R017 |   Ring 11                                           |  not used   |  0.000E+00  |               ---                  | FRACA(11)
R017 |   Ring 12                                           |  not used   |  0.000E+00  |               ---                  | FRACA(12)
     |                                                     |             |             |                                    |
R018 | Fruits, vegetables and grain consumption (kg/yr)    |  not used   |  1.600E+02  |               ---                  | DIET(1)
R018 | Leafy vegetable consumption (kg/yr)                 |  not used   |  1.400E+01  |               ---                  | DIET(2)
R018 | Milk consumption (L/yr)                             |  not used   |  9.200E+01  |               ---                  | DIET(3)
R018 | Meat and poultry consumption (kg/yr)                |  not used   |  6.300E+01  |               ---                  | DIET(4)
R018 | Fish consumption (kg/yr)                            |  not used   |  5.400E+00  |               ---                  | DIET(5)
R018 | Other seafood consumption (kg/yr)                   |  not used   |  9.000E-01  |               ---                  | DIET(6)
R018 | Soil ingestion rate (g/yr)                          |  2.800E+00  |  3.650E+01  |               ---                  | SOIL
```

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                                 Site-Specific Parameter Summary (continued)

      |                                                   |   User     |            |      Used by RESRAD            | Parameter
Menu  |                   Parameter                       |   Input    |  Default   | (If different from user input) |   Name
-----------------------------------------------------------------------------------------------------------------------------
R018  | Drinking water intake (L/yr)                      | 1.400E+01  | 5.100E+02  |              ---               | DWI
R018  | Contamination fraction of drinking water          | 1.000E+00  | 1.000E+00  |              ---               | FDW
R018  | Contamination fraction of household water         | not used   | 1.000E+00  |              ---               | FHHW
R018  | Contamination fraction of livestock water         | not used   | 1.000E+00  |              ---               | FLW
R018  | Contamination fraction of irrigation water        | not used   | 1.000E+00  |              ---               | FIRW
R018  | Contamination fraction of aquatic food            | not used   | 5.000E-01  |              ---               | FR9
R018  | Contamination fraction of plant food              | not used   |-1          |              ---               | FPLANT
R018  | Contamination fraction of meat                    | not used   |-1          |              ---               | FMEAT
R018  | Contamination fraction of milk                    | not used   |-1          |              ---               | FMILK
      |                                                   |            |            |                                |
R019  | Livestock fodder intake for meat (kg/day)         | not used   | 6.800E+01  |              ---               | LFI5
R019  | Livestock fodder intake for milk (kg/day)         | not used   | 5.500E+01  |              ---               | LFI6
R019  | Livestock water intake for meat (L/day)           | not used   | 5.000E+01  |              ---               | LWI5
R019  | Livestock water intake for milk (L/day)           | not used   | 1.600E+02  |              ---               | LWI6
R019  | Livestock soil intake (kg/day)                    | not used   | 5.000E-01  |              ---               | LSI
R019  | Mass loading for foliar deposition (g/m**3)       | not used   | 1.000E-04  |              ---               | MLFD
R019  | Depth of soil mixing layer (m)                    | 1.500E-01  | 1.500E-01  |              ---               | DM
R019  | Depth of roots (m)                                | not used   | 9.000E-01  |              ---               | DROOT
R019  | Drinking water fraction from ground water         | 1.000E+00  | 1.000E+00  |              ---               | FGWDW
R019  | Household water fraction from ground water        | 1.000E+00  | 1.000E+00  |              ---               | FGWHH
R019  | Livestock water fraction from ground water        | not used   | 1.000E+00  |              ---               | FGWLW
R019  | Irrigation fraction from ground water             | not used   | 1.000E+00  |              ---               | FGWIR
      |                                                   |            |            |                                |
R19B  | Wet weight crop yield for Non-Leafy (kg/m**2)     | not used   | 7.000E-01  |              ---               | YV(1)
R19B  | Wet weight crop yield for Leafy     (kg/m**2)     | not used   | 1.500E+00  |              ---               | YV(2)
R19B  | Wet weight crop yield for Fodder    (kg/m**2)     | not used   | 1.100E+00  |              ---               | YV(3)
R19B  | Growing Season for  Non-Leafy (years)             | not used   | 1.700E-01  |              ---               | TE(1)
R19B  | Growing Season for  Leafy     (years)             | not used   | 2.500E-01  |              ---               | TE(2)
R19B  | Growing Season for  Fodder    (years)             | not used   | 8.000E-02  |              ---               | TE(3)
R19B  | Translocation Factor for  Non-Leafy               | not used   | 1.000E-01  |              ---               | TIV(1)
R19B  | Translocation Factor for  Leafy                   | not used   | 1.000E+00  |              ---               | TIV(2)
R19B  | Translocation Factor for  Fodder                  | not used   | 1.000E+00  |              ---               | TIV(3)
R19B  | Dry Foliar Interception Fraction for  Non-Leafy   | not used   | 2.500E-01  |              ---               | RDRY(1)
 19B  | Dry Foliar Interception Fraction for  Leafy       | not used   | 2.500E-01  |              ---               | RDRY(2)
 19B  | Dry Foliar Interception Fraction for  Fodder      | not used   | 2.500E-01  |              ---               | RDRY(3)
 19B  | Wet Foliar Interception Fraction for  Non-Leafy   | not used   | 2.500E-01  |              ---               | RWET(1)
 19B  | Wet Foliar Interception Fraction for  Leafy       | not used   | 2.500E-01  |              ---               | RWET(2)
 19B  | Wet Foliar Interception Fraction for  Fodder      | not used   | 2.500E-01  |              ---               | RWET(3)
 19B  | Weathering Removal Constant for Vegetation        | not used   | 2.000E+01  |              ---               | WLAM
      |                                                   |            |            |                                |
 14   | C-12 concentration in water (g/cm**3)             | not used   | 2.000E-05  |              ---               | C12WTR
 14   | C-12 concentration in contaminated soil (g/g)     | not used   | 3.000E-02  |              ---               | C12CZ
 14   | Fraction of vegetation carbon from soil           | not used   | 2.000E-02  |              ---               | CSOIL
 14   | Fraction of vegetation carbon from air            | not used   | 9.800E-01  |              ---               | CAIR
 14   | C-14 evasion layer thickness in soil (m)          | not used   | 3.000E-01  |              ---               | DMC
 14   | C-14 evasion flux rate from soil (1/sec)          | not used   | 7.000E-07  |              ---               | EVSN
 14   | C-12 evasion flux rate from soil (1/sec)          | not used   | 1.000E-10  |              ---               | REVSN
 14   | Fraction of grain in beef cattle feed             | not used   | 8.000E-01  |              ---               | AVFG4
 14   | Fraction of grain in milk cow feed                | not used   | 2.000E-01  |              ---               | AVFG5
```

```
                                              Site-Specific Parameter Summary (continued)

     |                                                     |    User     |             |          Used by RESRAD           |   Parameter
Menu |                    Parameter                        |    Input    |   Default   | (If different from user input)    |     Name
-----+-----------------------------------------------------+-------------+-------------+-----------------------------------+--------------
STOR | Storage times of contaminated foodstuffs (days):    |             |             |                                   |
STOR |   Fruits, non-leafy vegetables, and grain           |  1.400E+01  |  1.400E+01  |                ---                | STOR_T(1)
STOR |   Leafy vegetables                                  |  1.000E+00  |  1.000E+00  |                ---                | STOR_T(2)
STOR |   Milk                                              |  1.000E+00  |  1.000E+00  |                ---                | STOR_T(3)
STOR |   Meat and poultry                                  |  2.000E+01  |  2.000E+01  |                ---                | STOR_T(4)
STOR |   Fish                                              |  7.000E+00  |  7.000E+00  |                ---                | STOR_T(5)
STOR |   Crustacea and mollusks                            |  7.000E+00  |  7.000E+00  |                ---                | STOR_T(6)
STOR |   Well water                                        |  1.000E+00  |  1.000E+00  |                ---                | STOR_T(7)
STOR |   Surface water                                     |  1.000E+00  |  1.000E+00  |                ---                | STOR_T(8)
STOR |   Livestock fodder                                  |  4.500E+01  |  4.500E+01  |                ---                | STOR_T(9)
     |                                                     |             |             |                                   |
R021 | Thickness of building foundation (m)                |  not used   |  1.500E-01  |                ---                | FLOOR
R021 | Bulk density of building foundation (g/cm**3)       |  not used   |  2.400E+00  |                ---                | DENSFL
R021 | Total porosity of the cover material                |  not used   |  4.000E-01  |                ---                | TPCV
R021 | Total porosity of the building foundation           |  not used   |  1.000E-01  |                ---                | TPFL
R021 | Volumetric water content of the cover material      |  not used   |  5.000E-02  |                ---                | PH2OCV
R021 | Volumetric water content of the foundation          |  not used   |  3.000E-02  |                ---                | PH2OFL
R021 | Diffusion coefficient for radon gas (m/sec):        |             |             |                                   |
R021 |   in cover material                                 |  not used   |  2.000E-06  |                ---                | DIFCV
R021 |   in foundation material                            |  not used   |  3.000E-07  |                ---                | DIFFL
R021 |   in contaminated zone soil                         |  not used   |  2.000E-06  |                ---                | DIFCZ
R021 | Radon vertical dimension of mixing (m)              |  not used   |  2.000E+00  |                ---                | HMIX
R021 | Average building air exchange rate (1/hr)           |  not used   |  5.000E-01  |                ---                | REXG
R021 | Height of the building (room) (m)                   |  not used   |  2.500E+00  |                ---                | HRM
R021 | Building interior area factor                       |  not used   |  0.000E+00  |                ---                | FAI
R021 | Building depth below ground surface (m)             |  not used   | -1.000E+00  |                ---                | DMFL
R021 | Emanating power of Rn-222 gas                       |  not used   |  2.500E-01  |                ---                | EMANA(1)
R021 | Emanating power of Rn-220 gas                       |  not used   |  1.500E-01  |                ---                | EMANA(2)
=====+=====================================================+=============+=============+===================================+==============


                 Summary of Pathway Selections

             Pathway             |  User Selection
---------------------------------+------------------
      1 -- external gamma        |      active
      2 -- inhalation (w/o radon)|      active
      3 -- plant ingestion       |    suppressed
      4 -- meat ingestion        |    suppressed
      5 -- milk ingestion        |    suppressed
      6 -- aquatic foods         |    suppressed
      7 -- drinking water        |      active
      8 -- soil ingestion        |      active
      9 -- radon                 |    suppressed
      Find peak pathway doses    |    suppressed
=================================+==================
```

```
     Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
     ____________________________            __________________________________

        Area:  65000.00 square meters                 Cs-137      1.500E+00
   Thickness:      1.00 meters                        Pb-210      9.100E+00
 over Depth:       0.00 meters                        Th-230      2.200E+00
                                                      U-234       1.300E+00
                                                      U-238       1.400E+00


                                      Total Dose TDOSE(t), mrem/yr
                                Basic Radiation Dose Limit =  10 mrem/yr
                 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                 __________________________________________________________________________

      t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
       TDOSE(t):  1.777E+00  1.740E+00  1.602E+00  1.449E+00  1.094E+00  8.573E-01  7.039E-01  6.080E-01
           M(t):  1.777E-01  1.740E-01  1.602E-01  1.449E-01  1.094E-01  8.573E-02  7.039E-02  6.080E-02

aximum TDOSE(t):  1.777E+00 mrem/yr   at t = 0.000E+00 years
```

```
Summary : SEAD-63 Recreational child - Site Specific Parameters
File    : RECCHSED.RAD

                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                        Water Independent Pathways (Inhalation excludes radon)

            Ground              Inhalation              Radon                Plant                Meat                 Milk                 Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Cs-137   1.632E+00 0.9185   3.431E-08 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.930E-05 0.0000
Pb-210   1.826E-02 0.0103   1.514E-04 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.113E-02 0.0344
Th-230   8.662E-04 0.0005   5.142E-04 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.114E-03 0.0006
U-234    1.707E-04 0.0001   1.230E-04 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.399E-04 0.0002
U-238    6.151E-02 0.0346   1.184E-04 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.480E-04 0.0002
=======  ========= ======   ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total    1.713E+00 0.9640   9.071E-04 0.0005    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.300E-02 0.0355

                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                        Water Dependent Pathways

            Water                Fish               Radon                Plant                Meat                 Milk             All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Cs-137   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.632E+00 0.9186
Pb-210   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.954E-02 0.0448
Th-230   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.494E-03 0.0014
U-234    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.337E-04 0.0004
U-238    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.197E-02 0.0349
=======  ========= ======   ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.777E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
RESRAD, Ve       .82    T½ Limit = 0.5 year       10/15/99  13:4     Page  11
Summary : SE     Recreational child - Site Specific Parameters
File    : RECCHSED.RAD

                       Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                   Water Independent Pathways (Inhalation excludes radon)

              Ground            Inhalation            Radon              Plant               Meat               Milk               Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  1.594E+00 0.9164  3.352E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.771E-05 0.0000
Pb-210  1.768E-02 0.0102  1.466E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.919E-02 0.0340
Th-230  4.277E-03 0.0025  5.142E-04 0.0003  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.115E-03 0.0006
U-234   1.704E-04 0.0001  1.228E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.392E-04 0.0002
U-238   6.136E-02 0.0353  1.182E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.472E-04 0.0002
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.678E+00 0.9644  9.018E-04 0.0005  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.106E-02 0.0351

                       Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                 Water Dependent Pathways

              Water              Fish               Radon              Plant               Meat               Milk          All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.595E+00 0.9164
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.702E-02 0.0443
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.907E-03 0.0034
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.323E-04 0.0004
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.183E-02 0.0355
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.740E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                       Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                       As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                         Water Independent Pathways (Inhalation excludes radon)

             Ground             Inhalation            Radon                Plant                Meat                 Milk                 Soil
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137  1.453E+00 0.9069  3.055E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.170E-05 0.0000
Pb-210  1.554E-02 0.0097  1.288E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.203E-02 0.0325
Th-230  1.785E-02 0.0111  5.142E-04 0.0003  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.122E-03 0.0007
U-234   1.690E-04 0.0001  1.216E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.361E-04 0.0002
U-238   6.080E-02 0.0379  1.171E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.440E-04 0.0002
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.547E+00 0.9658  8.818E-04 0.0006  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.389E-02 0.0336

                       Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                       As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                         Water Dependent Pathways

             Water                Fish               Radon                Plant                Meat                 Milk             All Pathways*
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.453E+00 0.9070
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.770E-02 0.0423
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.949E-02 0.0122
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.267E-04 0.0004
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.126E-02 0.0382
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.602E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                       Water Independent Pathways (Inhalation excludes radon)

             Ground           Inhalation           Radon              Plant              Meat               Milk               Soil
Radio-  ------------------ ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  1.294E+00 0.8929  2.720E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.494E-05 0.0000
Pb-210  1.323E-02 0.0091  1.097E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.428E-02 0.0306
Th-230  3.466E-02 0.0239  5.143E-04 0.0004  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.134E-03 0.0008
U-234   1.678E-04 0.0001  1.202E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.322E-04 0.0002
U-238   6.010E-02 0.0415  1.157E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.400E-04 0.0002
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.402E+00 0.9676  8.599E-04 0.0006  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.614E-02 0.0318

                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                     Water Dependent Pathways

             Water              Fish              Radon              Plant              Meat               Milk          All Pathways*
adio-   ------------------ ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
uclide   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
s-137   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.294E+00 0.8930
b-210   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.762E-02 0.0398
h-230   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.631E-02 0.0251
-234    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.202E-04 0.0004
-238    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.056E-02 0.0418
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
otal    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.449E+00 1.0000
Sum of all water independent and dependent pathways.
```

```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                        Water Independent Pathways (Inhalation excludes radon)

            Ground              Inhalation            Radon                Plant                Meat                 Milk                 Soil
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
-------  --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Cs-137  9.132E-01 0.8350  1.920E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.878E-05 0.0000
Pb-210  8.157E-03 0.0075  6.761E-05 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.730E-02 0.0250
Th-230  8.405E-02 0.0768  5.143E-04 0.0005  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.190E-03 0.0011
U-234   1.667E-04 0.0002  1.162E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.210E-04 0.0003
U-238   5.805E-02 0.0531  1.118E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.285E-04 0.0003
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.064E+00 0.9726  8.100E-04 0.0007  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.918E-02 0.0267

                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                      Water Dependent Pathways

            Water                Fish                Radon                Plant                Meat                 Milk            All Pathways*
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
-------  --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.133E-01 0.8351
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.553E-02 0.0325
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.575E-02 0.0784
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.039E-04 0.0006
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.849E-02 0.0535
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.094E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                      Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                   Water Independent Pathways (Inhalation excludes radon)

                 Ground             Inhalation              Radon                 Plant                  Meat                  Milk                  Soil
Radio-    -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Cs-137   6.446E-01 0.7519  1.355E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.737E-05 0.0000
Pb-210   5.029E-03 0.0059  4.168E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.683E-02 0.0196
Th-230   1.319E-01 0.1539  5.145E-04 0.0006  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.263E-03 0.0015
U-234    1.695E-04 0.0002  1.123E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.101E-04 0.0004
U-238    5.607E-02 0.0654  1.080E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.173E-04 0.0004
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    8.378E-01 0.9772  7.764E-04 0.0009  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.875E-02 0.0219


                      Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                                 Water Dependent Pathways

                 Water                 Fish                 Radon                 Plant                  Meat                  Milk            All Pathways*
Radio-    -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Cs-137   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.447E-01 0.7519
Pb-210   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.190E-02 0.0255
Th-230   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.337E-01 0.1559
U-234    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.919E-04 0.0007
U-238    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.650E-02 0.0659
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.573E-01 1.0000

*Sum of all water independent and dependent pathways.
```

```
                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                     Water Independent Pathways (Inhalation excludes radon)

               Ground           Inhalation          Radon              Plant              Meat               Milk               Soil
Radio-  ------------------  ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Cs-137  4.550E-01 0.6465  9.566E-09 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.932E-05 0.0000
Pb-210  3.101E-03 0.0044  2.570E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.038E-02 0.0147
Th-230  1.783E-01 0.2533  5.147E-04 0.0007  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.347E-03 0.0019
U-234   1.759E-04 0.0002  1.085E-04 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.996E-04 0.0004
U-238   5.416E-02 0.0769  1.043E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.065E-04 0.0004
======= ========== ======  ========== ======  ========== ======  ========== ======  ========== ======  ========== ======  ========== ======
Total   6.908E-01 0.9814  7.531E-04 0.0011  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.235E-02 0.0175

                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                   Water Dependent Pathways

                Water              Fish             Radon              Plant              Meat               Milk          All Pathways*
Radio-  ------------------  ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.551E-01 0.6465
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.350E-02 0.0192
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.802E-01 0.2559
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.840E-04 0.0008
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.457E-02 0.0775
======= ========== ======  ========== ======  ========== ======  ========== ======  ========== ======  ========== ======  ========== ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.039E-01 1.0000

*Sum of all water independent and dependent pathways.
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                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                   As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                         Water Independent Pathways (Inhalation excludes radon)

             Ground            Inhalation            Radon              Plant              Meat               Milk               Soil
Radio-  ------------------ ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------
Cs-137  3.212E-01 0.5283 6.753E-09 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.364E-05 0.0000
Pb-210  1.912E-03 0.0031 1.585E-05 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 6.399E-03 0.0105
Th-230  2.232E-01 0.3672 5.148E-04 0.0008 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.436E-03 0.0024
U-234   1.857E-04 0.0003 1.048E-04 0.0002 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.895E-04 0.0005
U-238   5.232E-02 0.0860 1.008E-04 0.0002 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.960E-04 0.0005
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
Total   5.989E-01 0.9849 7.363E-04 0.0012 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 8.434E-03 0.0139

                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                   As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                     Water Dependent Pathways

             Water               Fish              Radon              Plant              Meat               Milk          All Pathways*
adio-   ------------------ ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
uclide   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------
s-137   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.212E-01 0.5283
b-210   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 8.326E-03 0.0137
h-230   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.252E-01 0.3704
-234    0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 5.800E-04 0.0010
-238    0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 5.271E-02 0.0867
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
otal    0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 6.080E-01 1.0000

 Sum of all water independent and dependent pathways.
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                                 Dose/Source Ratios Summed Over All Pathways
                        Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                                DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)      (j)     Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
-------  -------  ---------    --------- --------- --------- --------- --------- --------- --------- ---------
Cs-137   Cs-137   1.000E+00    1.088E+00 1.063E+00 9.687E-01 8.626E-01 6.089E-01 4.298E-01 3.034E-01 2.141E-01

Pb-210   Pb-210   1.000E+00    8.741E-03 8.464E-03 7.440E-03 6.332E-03 3.904E-03 2.407E-03 1.484E-03 9.150E-04

Th-230   Th-230   1.000E+00    1.134E-03 1.134E-03 1.134E-03 1.134E-03 1.134E-03 1.133E-03 1.133E-03 1.133E-03
Th-230   Ra-226   1.000E+00    0.000E+00 1.551E-03 7.723E-03 1.536E-02 3.782E-02 5.957E-02 8.065E-02 1.011E-01
Th-230   Pb-210   1.000E+00    0.000E+00 5.818E-08 1.390E-06 5.263E-06 2.808E-05 6.206E-05 1.023E-04 1.458E-04
Th-230   ∑DSR(j)               1.134E-03 2.685E-03 8.858E-03 1.650E-02 3.898E-02 6.077E-02 8.189E-02 1.024E-01

U-234    U-234    1.000E+00    4.875E-04 4.863E-04 4.819E-04 4.763E-04 4.601E-04 4.444E-04 4.292E-04 4.145E-04
U-234    Th-230   1.000E+00    0.000E+00 1.019E-08 5.074E-08 1.009E-07 2.479E-07 3.898E-07 5.269E-07 6.593E-07
U-234    Ra-226   1.000E+00    0.000E+00 6.978E-09 1.734E-07 6.886E-07 4.210E-06 1.054E-05 1.950E-05 3.091E-05
U-234    Pb-210   1.000E+00    0.000E+00 1.750E-13 2.109E-11 1.614E-10 2.218E-09 8.045E-09 1.864E-08 3.446E-08
U-234    ∑DSR(j)               4.875E-04 4.864E-04 4.821E-04 4.771E-04 4.645E-04 4.553E-04 4.492E-04 4.462E-04

U-238    U-238    1.000E+00    4.427E-02 4.416E-02 4.376E-02 4.325E-02 4.178E-02 4.036E-02 3.898E-02 3.765E-02
U-238    U-234    1.000E+00    0.000E+00 1.379E-09 6.830E-09 1.350E-08 3.261E-08 5.039E-08 6.693E-08 8.227E-08
U-238    Th-230   1.000E+00    0.000E+00 1.445E-14 3.589E-13 1.425E-12 8.700E-12 2.177E-11 4.022E-11 6.367E-11
U-238    Ra-226   1.000E+00    0.000E+00 6.594E-15 8.186E-13 6.494E-12 9.894E-11 3.952E-10 1.002E-09 2.015E-09
U-238    Pb-210   1.000E+00    0.000E+00 1.262E-19 7.525E-17 1.159E-15 4.054E-14 2.390E-13 7.722E-13 1.839E-12
U-238    ∑DSR(j)               4.427E-02 4.416E-02 4.376E-02 4.325E-02 4.178E-02 4.036E-02 3.898E-02 3.765E-02
=======  =======  =========    ========= ========= ========= ========= ========= ========= ========= =========
*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.


                           Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                                 Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)     t= 0.000E+00    1.000E+00    5.000E+00    1.000E+01    2.500E+01    4.000E+01    5.500E+01    7.000E+01
-------      ---------    ---------    ---------    ---------    ---------    ---------    ---------    ---------
Cs-137       9.191E+00    9.407E+00    1.032E+01    1.159E+01    1.642E+01    2.327E+01    3.296E+01    4.670E+01
Pb-210       1.144E+03    1.182E+03    1.344E+03    1.579E+03    2.561E+03    4.155E+03    6.738E+03    1.093E+04
Th-230       8.820E+03    3.725E+03    1.129E+03    6.059E+02    2.566E+02    1.646E+02    1.221E+02    9.770E+01
U-234        2.051E+04    2.056E+04    2.074E+04    2.096E+04    2.153E+04    2.196E+04    2.226E+04    2.241E+04
U-238        2.259E+02    2.264E+02    2.285E+02    2.312E+02    2.393E+02    2.478E+02    2.565E+02    2.656E+02
=======      =========    =========    =========    =========    =========    =========    =========    =========
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           Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
           and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
        at tmin = time of minimum single radionuclide soil guideline
    and at tmax = time of maximum total dose = 0.000E+00 years

uclide  Initial         tmin       DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
 (i)     pCi/g        (years)                   (pCi/g)              (pCi/g)
______ __________   ______________  __________ __________ __________ __________
s-137  1.500E+00      0.000E+00     1.088E+00  9.191E+00  1.088E+00  9.191E+00
b-210  9.100E+00      0.000E+00     8.741E-03  1.144E+03  8.741E-03  1.144E+03
h-230  2.200E+00      7.000E+01     1.024E-01  9.770E+01  1.134E-03  8.820E+03
-234   1.300E+00      0.000E+00     4.875E-04  2.051E+04  4.875E-04  2.051E+04
-238   1.400E+00      0.000E+00     4.427E-02  2.259E+02  4.427E-02  2.259E+02
______ __________   ______________  __________ __________ __________ __________
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                                   Individual Nuclide Dose Summed Over All Pathways
                                     Parent Nuclide and Branch Fraction Indicated

Nuclide Parent    BRF(i)                                      DOSE(j,t), mrem/yr
  (j)     (i)                t=  0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ _______ _________        _________ _________ _________ _________ _________ _________ _________ _________

Cs-137  Cs-137  1.000E+00        1.632E+00 1.595E+00 1.453E+00 1.294E+00 9.133E-01 6.447E-01 4.551E-01 3.212E-01

Pb-210  Pb-210  1.000E+00        7.954E-02 7.702E-02 6.770E-02 5.762E-02 3.553E-02 2.190E-02 1.350E-02 8.326E-03
Pb-210  Th-230  1.000E+00        0.000E+00 1.280E-07 3.059E-06 1.158E-05 6.178E-05 1.365E-04 2.250E-04 3.207E-04
Pb-210  U-234   1.000E+00        0.000E+00 2.275E-13 2.742E-11 2.098E-10 2.883E-09 1.046E-08 2.423E-08 4.480E-08
Pb-210  U-238   1.000E+00        0.000E+00 1.767E-19 1.054E-16 1.623E-15 5.675E-14 3.346E-13 1.081E-12 2.574E-12
Pb-210  ∑DOSE(j):                7.954E-02 7.702E-02 6.770E-02 5.763E-02 3.559E-02 2.204E-02 1.373E-02 8.647E-03

Th-230  Th-230  1.000E+00        2.494E-03 2.494E-03 2.494E-03 2.494E-03 2.494E-03 2.493E-03 2.493E-03 2.493E-03
Th-230  U-234   1.000E+00        0.000E+00 1.325E-08 6.596E-08 1.312E-07 3.223E-07 5.068E-07 6.850E-07 8.571E-07
Th-230  U-238   1.000E+00        0.000E+00 2.022E-14 5.025E-13 1.994E-12 1.218E-11 3.047E-11 5.630E-11 8.913E-11
Th-230  ∑DOSE(j):                2.494E-03 2.494E-03 2.494E-03 2.494E-03 2.494E-03 2.494E-03 2.494E-03 2.493E-03

Ra-226  Th-230  1.000E+00        0.000E+00 3.412E-03 1.699E-02 3.380E-02 8.319E-02 1.311E-01 1.774E-01 2.224E-01
Ra-226  U-234   1.000E+00        0.000E+00 9.071E-09 2.255E-07 8.952E-07 5.473E-06 1.371E-05 2.536E-05 4.019E-05
Ra-226  U-238   1.000E+00        0.000E+00 9.232E-15 1.146E-12 9.091E-12 1.385E-10 5.533E-10 1.403E-09 2.820E-09
Ra-226  ∑DOSE(j):                0.000E+00 3.412E-03 1.699E-02 3.380E-02 8.320E-02 1.311E-01 1.775E-01 2.224E-01

U-234   U-234   1.000E+00        6.337E-04 6.323E-04 6.264E-04 6.192E-04 5.981E-04 5.777E-04 5.580E-04 5.389E-04
U-234   U-238   1.000E+00        0.000E+00 1.930E-09 9.563E-09 1.891E-08 4.565E-08 7.055E-08 9.370E-08 1.152E-07
U-234   ∑DOSE(j):                6.337E-04 6.323E-04 6.264E-04 6.192E-04 5.981E-04 5.777E-04 5.580E-04 5.390E-04

U-238   U-238   1.000E+00        6.197E-02 6.183E-02 6.126E-02 6.056E-02 5.849E-02 5.650E-02 5.457E-02 5.271E-02
======= ======= =========        ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
```

```
                                   Individual Nuclide Soil Concentration
                                Parent Nuclide and Branch Fraction Indicated

Nuclide  Parent    BRF(i)                                         S(j,t), pCi/g
  (j)     (i)              t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______  _______  _________   _________ _________ _________ _________ _________ _________ _________ _________

Cs-137   Cs-137   1.000E+00   1.500E+00 1.466E+00 1.336E+00 1.189E+00 8.394E-01 5.925E-01 4.182E-01 2.952E-01

Pb-210   Pb-210   1.000E+00   9.100E+00 8.811E+00 7.745E+00 6.592E+00 4.064E+00 2.506E+00 1.545E+00 9.526E-01
Pb-210   Th-230   1.000E+00   0.000E+00 1.464E-05 3.499E-04 1.325E-03 7.068E-03 1.562E-02 2.574E-02 3.669E-02
Pb-210   U-234    1.000E+00   0.000E+00 2.602E-11 3.137E-09 2.401E-08 3.299E-07 1.197E-06 2.772E-06 5.125E-06
Pb-210   U-238    1.000E+00   0.000E+00 2.021E-17 1.205E-14 1.857E-13 6.493E-12 3.828E-11 1.237E-10 2.945E-10
Pb-210   ∑S(j):               9.100E+00 8.811E+00 7.746E+00 6.593E+00 4.071E+00 2.521E+00 1.571E+00 9.893E-01

Th-230   Th-230   1.000E+00   2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00 2.198E+00
Th-230   U-234    1.000E+00   0.000E+00 1.169E-05 5.817E-05 1.157E-04 2.842E-04 4.470E-04 6.042E-04 7.559E-04
Th-230   U-238    1.000E+00   0.000E+00 1.784E-11 4.432E-10 1.759E-09 1.074E-08 2.687E-08 4.966E-08 7.861E-08
Th-230   ∑S(j):               2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00

Ra-226   Th-230   1.000E+00   0.000E+00 9.521E-04 4.740E-03 9.432E-03 2.321E-02 3.657E-02 4.951E-02 6.205E-02
Ra-226   U-234    1.000E+00   0.000E+00 2.531E-09 6.291E-08 2.498E-07 1.527E-06 3.825E-06 7.075E-06 1.121E-05
Ra-226   U-238    1.000E+00   0.000E+00 2.576E-15 3.198E-13 2.537E-12 3.865E-11 1.544E-10 3.914E-10 7.870E-10
Ra-226   ∑S(j):               0.000E+00 9.521E-04 4.741E-03 9.432E-03 2.321E-02 3.657E-02 4.952E-02 6.206E-02

U-234    U-234    1.000E+00   1.300E+00 1.297E+00 1.285E+00 1.270E+00 1.227E+00 1.185E+00 1.145E+00 1.106E+00
U-234    U-238    1.000E+00   0.000E+00 3.960E-06 1.962E-05 3.878E-05 9.365E-05 1.447E-04 1.922E-04 2.363E-04
U-234    ∑S(j):               1.300E+00 1.297E+00 1.285E+00 1.270E+00 1.227E+00 1.185E+00 1.145E+00 1.106E+00

U-238    U-238    1.000E+00   1.400E+00 1.397E+00 1.384E+00 1.368E+00 1.321E+00 1.276E+00 1.233E+00 1.191E+00
=======  =======  =========   ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
```

RESRAD OUTPUT FOR RESIDENT – SEDIMENT
SUPPORT FOR COMPLIANCE WITH NYSDEC TAGM

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

```
                         Dose Conversion Factor (and Related) Parameter Summary
                                          File: DOSFAC.BIN

     |                                                 | Current   |           | Parameter
Menu |                   Parameter                     |  Value    |  Default  |   Name
-----+-------------------------------------------------+-----------+-----------+--------------
B-1  | Dose conversion factors for inhalation, mrem/pCi:
B-1  | Cs-137+D                                        | 3.190E-05 | 3.190E-05 | DCF2( 1)
B-1  | Pb-210+D                                        | 2.320E-02 | 2.320E-02 | DCF2( 2)
B-1  | Ra-226+D                                        | 8.600E-03 | 8.600E-03 | DCF2( 3)
B-1  | Th-230                                          | 3.260E-01 | 3.260E-01 | DCF2( 4)
B-1  | U-234                                           | 1.320E-01 | 1.320E-01 | DCF2( 5)
B-1  | U-238+D                                         | 1.180E-01 | 1.180E-01 | DCF2( 6)
     |                                                 |           |           |
D-1  | Dose conversion factors for ingestion, mrem/pCi:
D-1  | Cs-137+D                                        | 5.000E-05 | 5.000E-05 | DCF3( 1)
D-1  | Pb-210+D                                        | 7.270E-03 | 7.270E-03 | DCF3( 2)
D-1  | Ra-226+D                                        | 1.330E-03 | 1.330E-03 | DCF3( 3)
D-1  | Th-230                                          | 5.480E-04 | 5.480E-04 | DCF3( 4)
D-1  | U-234                                           | 2.830E-04 | 2.830E-04 | DCF3( 5)
D-1  | U-238+D                                         | 2.690E-04 | 2.690E-04 | DCF3( 6)
     |                                                 |           |           |
D-34 | Food transfer factors:
D-34 | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 1,1)
D-34 | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 1,2)
D-34 | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 8.000E-03 | 8.000E-03 | RTF( 1,3)
D-34 |
D-34 | Pb-210+D , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 2,1)
D-34 | Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04 | 8.000E-04 | RTF( 2,2)
D-34 | Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 3.000E-04 | 3.000E-04 | RTF( 2,3)
D-34 |
D-34 | Ra-226+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 3,1)
D-34 | Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF( 3,2)
D-34 | Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03 | 1.000E-03 | RTF( 3,3)
D-34 |
D-34 | Th-230   , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 4,1)
D-34 | Th-230   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 4,2)
D-34 | Th-230   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF( 4,3)
D-34 |
D-34 | U-234    , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 5,1)
D-34 | U-234    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 5,2)
D-34 | U-234    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF( 5,3)
D-34 |
D-34 | U-238+D  , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 6,1)
D-34 | U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 6,2)
D-34 | U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF( 6,3)
     |                                                 |           |           |
D-5  | Bioaccumulation factors, fresh water, L/kg:
D-5  | Cs-137+D , fish                                 | 2.000E+03 | 2.000E+03 | BIOFAC( 1,1)
D-5  | Cs-137+D , crustacea and mollusks               | 1.000E+02 | 1.000E+02 | BIOFAC( 1,2)
D-5  |
D-5  | Pb-210+D , fish                                 | 3.000E+02 | 3.000E+02 | BIOFAC( 2,1)
D-5  | Pb-210+D , crustacea and mollusks               | 1.000E+02 | 1.000E+02 | BIOFAC( 2,2)
D-5  |
D-5  | Ra-226+D , fish                                 | 5.000E+01 | 5.000E+01 | BIOFAC( 3,1)
D-5  | Ra-226+D , crustacea and mollusks               | 2.500E+02 | 2.500E+02 | BIOFAC( 3,2)
D-5  |
```

```
                Dose Conversion Factor (and Related) Parameter Summary (continued)
                                   File: DOSFAC.BIN

     |                                                         | Current  |          | Parameter
Menu |                       Parameter                         |  Value   | Default  |   Name
-----+---------------------------------------------------------+----------+----------+------------
D-5  | Th-230   , fish                                         | 1.000E+02| 1.000E+02| BIOFAC( 4,1)
D-5  | Th-230   , crustacea and mollusks                       | 5.000E+02| 5.000E+02| BIOFAC( 4,2)
D-5  |                                                         |          |          |
D-5  | U-234    , fish                                         | 1.000E+01| 1.000E+01| BIOFAC( 5,1)
D-5  | U-234    , crustacea and mollusks                       | 6.000E+01| 6.000E+01| BIOFAC( 5,2)
D-5  |                                                         |          |          |
D-5  | U-238+D  , fish                                         | 1.000E+01| 1.000E+01| BIOFAC( 6,1)
D-5  | U-238+D  , crustacea and mollusks                       | 6.000E+01| 6.000E+01| BIOFAC( 6,2)
=====+=========================================================+==========+==========+============
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                                                      Site-Specific Parameter Summary

     |                                                          |    User    |            |        Used by RESRAD              |  Parameter
Menu |                         Parameter                        |    Input   |  Default   | (If different from user input)     |    Name
-----+----------------------------------------------------------+------------+------------+------------------------------------+-----------
R011 | Area of contaminated zone (m**2)                         | 6.500E+04  | 1.000E+04  |               ---                  | AREA
R011 | Thickness of contaminated zone (m)                       | 1.000E+00  | 2.000E+00  |               ---                  | THICK0
R011 | Length parallel to aquifer flow (m)                      | 2.170E+02  | 1.000E+02  |               ---                  | LCZPAQ
R011 | Basic radiation dose limit (mrem/yr)                     | 1.000E+01  | 3.000E+01  |               ---                  | BRDL
R011 | Time since placement of material (yr)                    | 0.000E+00  | 0.000E+00  |               ---                  | TI
R011 | Times for calculations (yr)                              | 1.000E+00  | 1.000E+00  |               ---                  | T( 2)
R011 | Times for calculations (yr)                              | 5.000E+00  | 3.000E+00  |               ---                  | T( 3)
R011 | Times for calculations (yr)                              | 1.000E+01  | 1.000E+01  |               ---                  | T( 4)
R011 | Times for calculations (yr)                              | 2.500E+01  | 3.000E+01  |               ---                  | T( 5)
R011 | Times for calculations (yr)                              | 4.000E+01  | 1.000E+02  |               ---                  | T( 6)
R011 | Times for calculations (yr)                              | 5.500E+01  | 3.000E+02  |               ---                  | T( 7)
R011 | Times for calculations (yr)                              | 7.000E+01  | 1.000E+03  |               ---                  | T( 8)
R011 | Times for calculations (yr)                              | not used   | 0.000E+00  |               ---                  | T( 9)
R011 | Times for calculations (yr)                              | not used   | 0.000E+00  |               ---                  | T(10)
     |                                                          |            |            |                                    |
R012 | Initial principal radionuclide (pCi/g):  Cs-137          | 1.500E+00  | 0.000E+00  |               ---                  | S1( 1)
R012 | Initial principal radionuclide (pCi/g):  Pb-210          | 9.100E+00  | 0.000E+00  |               ---                  | S1( 2)
R012 | Initial principal radionuclide (pCi/g):  Th-230          | 2.200E+00  | 0.000E+00  |               ---                  | S1( 4)
R012 | Initial principal radionuclide (pCi/g):  U-234           | 1.300E+00  | 0.000E+00  |               ---                  | S1( 5)
R012 | Initial principal radionuclide (pCi/g):  U-238           | 1.400E+00  | 0.000E+00  |               ---                  | S1( 6)
R012 | Concentration in groundwater   (pCi/L):  Cs-137          | not used   | 0.000E+00  |               ---                  | W1( 1)
R012 | Concentration in groundwater   (pCi/L):  Pb-210          | not used   | 0.000E+00  |               ---                  | W1( 2)
R012 | Concentration in groundwater   (pCi/L):  Th-230          | not used   | 0.000E+00  |               ---                  | W1( 4)
R012 | Concentration in groundwater   (pCi/L):  U-234           | not used   | 0.000E+00  |               ---                  | W1( 5)
R012 | Concentration in groundwater   (pCi/L):  U-238           | not used   | 0.000E+00  |               ---                  | W1( 6)
     |                                                          |            |            |                                    |
R013 | Cover depth (m)                                          | 0.000E+00  | 0.000E+00  |               ---                  | COVER0
R013 | Density of cover material (g/cm**3)                      | not used   | 1.500E+00  |               ---                  | DENSCV
R013 | Cover depth erosion rate (m/yr)                          | not used   | 1.000E-03  |               ---                  | VCV
R013 | Density of contaminated zone (g/cm**3)                   | 1.500E+00  | 1.500E+00  |               ---                  | DENSCZ
R013 | Contaminated zone erosion rate (m/yr)                    | 6.000E-05  | 1.000E-03  |               ---                  | VCZ
R013 | Contaminated zone total porosity                         | 3.700E-01  | 4.000E-01  |               ---                  | TPCZ
R013 | Contaminated zone effective porosity                     | 1.750E-01  | 2.000E-01  |               ---                  | EPCZ
R013 | Contaminated zone hydraulic conductivity (m/yr)          | 2.080E+02  | 1.000E+01  |               ---                  | HCCZ
R013 | Contaminated zone b parameter                            | 7.750E+00  | 5.300E+00  |               ---                  | BCZ
R013 | Average annual wind speed (m/sec)                        | 3.000E+00  | 2.000E+00  |               ---                  | WIND
R013 | Humidity in air (g/m**3)                                 | not used   | 8.000E+00  |               ---                  | HUMID
R013 | Evapotranspiration coefficient                           | 7.000E-01  | 5.000E-01  |               ---                  | EVAPTR
R013 | Precipitation (m/yr)                                     | 7.500E-01  | 1.000E+00  |               ---                  | PRECIP
R013 | Irrigation (m/yr)                                        | 0.000E+00  | 2.000E-01  |               ---                  | RI
R013 | Irrigation mode                                          | overhead   | overhead   |               ---                  | IDITCH
R013 | Runoff coefficient                                       | 2.000E-01  | 2.000E-01  |               ---                  | RUNOFF
R013 | Watershed area for nearby stream or pond (m**2)          | 1.300E+07  | 1.000E+06  |               ---                  | WAREA
R013 | Accuracy for water/soil computations                     | 1.000E-03  | 1.000E-03  |               ---                  | EPS
     |                                                          |            |            |                                    |
R014 | Density of saturated zone (g/cm**3)                      | 1.500E+00  | 1.500E+00  |               ---                  | DENSAQ
R014 | Saturated zone total porosity                            | 3.700E-01  | 4.000E-01  |               ---                  | TPSZ
R014 | Saturated zone effective porosity                        | 1.750E-01  | 2.000E-01  |               ---                  | EPSZ
R014 | Saturated zone hydraulic conductivity (m/yr)             | 2.080E+02  | 1.000E+02  |               ---                  | HCSZ
R014 | Saturated zone hydraulic gradient                        | 1.200E-02  | 2.000E-02  |               ---                  | HGWT
R014 | Saturated zone b parameter                               | 1.040E+01  | 5.300E+00  |               ---                  | BSZ
```

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                                              Site-Specific Parameter Summary (continued)

     |                                                 |   User    |           |      Used by RESRAD              |  Parameter
Menu |                  Parameter                      |   Input   |  Default  | (If different from user input)   |    Name
-----+-------------------------------------------------+-----------+-----------+----------------------------------+------------
R014 | Water table drop rate (m/yr)                    | 0.000E+00 | 1.000E-03 |               ---                | VWT
R014 | Well pump intake depth (m below water table)    | 3.000E+00 | 1.000E+01 |               ---                | DWIBWT
R014 | Model: Nondispersion (ND) or Mass-Balance (MB)  | ND        | ND        |               ---                | MODEL
R014 | Well pumping rate (m**3/yr)                     | 5.000E+01 | 2.500E+02 |               ---                | UW
     |                                                 |           |           |                                  |
R015 | Number of unsaturated zone strata               | 1         | 1         |               ---                | NS
R015 | Unsat. zone 1, thickness (m)                    | 1.000E+00 | 4.000E+00 |               ---                | H(1)
R015 | Unsat. zone 1, soil density (g/cm**3)           | 1.500E+00 | 1.500E+00 |               ---                | DENSUZ(1)
R015 | Unsat. zone 1, total porosity                   | 3.700E-01 | 4.000E-01 |               ---                | TPUZ(1)
R015 | Unsat. zone 1, effective porosity               | 1.750E-01 | 2.000E-01 |               ---                | EPUZ(1)
R015 | Unsat. zone 1, soil-specific b parameter        | 7.750E+00 | 5.300E+00 |               ---                | BUZ(1)
R015 | Unsat. zone 1, hydraulic conductivity (m/yr)    | 2.080E+02 | 1.000E+01 |               ---                | HCUZ(1)
     |                                                 |           |           |                                  |
R016 | Distribution coefficients for Cs-137            |           |           |                                  |
R016 |   Contaminated zone (cm**3/g)                   | 1.000E+03 | 1.000E+03 |               ---                | DCNUCC( 1)
R016 |   Unsaturated zone 1 (cm**3/g)                  | 1.000E+03 | 1.000E+03 |               ---                | DCNUCU( 1,1)
R016 |   Saturated zone (cm**3/g)                      | 1.000E+03 | 1.000E+03 |               ---                | DCNUCS( 1)
R016 |   Leach rate (/yr)                              | 0.000E+00 | 0.000E+00 |            1.200E-04             | ALEACH( 1)
R016 |   Solubility constant                           | 0.000E+00 | 0.000E+00 |            not used              | SOLUBK( 1)
     |                                                 |           |           |                                  |
R016 | Distribution coefficients for Pb-210            |           |           |                                  |
R016 |   Contaminated zone (cm**3/g)                   | 1.000E+02 | 1.000E+02 |               ---                | DCNUCC( 2)
R016 |   Unsaturated zone 1 (cm**3/g)                  | 1.000E+02 | 1.000E+02 |               ---                | DCNUCU( 2,1)
R016 |   Saturated zone (cm**3/g)                      | 1.000E+02 | 1.000E+02 |               ---                | DCNUCS( 2)
R016 |   Leach rate (/yr)                              | 0.000E+00 | 0.000E+00 |            1.198E-03             | ALEACH( 2)
R016 |   Solubility constant                           | 0.000E+00 | 0.000E+00 |            not used              | SOLUBK( 2)
     |                                                 |           |           |                                  |
R016 | Distribution coefficients for Th-230            |           |           |                                  |
R016 |   Contaminated zone (cm**3/g)                   | 6.000E+04 | 6.000E+04 |               ---                | DCNUCC( 4)
R016 |   Unsaturated zone 1 (cm**3/g)                  | 6.000E+04 | 6.000E+04 |               ---                | DCNUCU( 4,1)
R016 |   Saturated zone (cm**3/g)                      | 6.000E+04 | 6.000E+04 |               ---                | DCNUCS( 4)
R016 |   Leach rate (/yr)                              | 0.000E+00 | 0.000E+00 |            2.000E-06             | ALEACH( 4)
R016 |   Solubility constant                           | 0.000E+00 | 0.000E+00 |            not used              | SOLUBK( 4)
     |                                                 |           |           |                                  |
R016 | Distribution coefficients for U-234             |           |           |                                  |
R016 |   Contaminated zone (cm**3/g)                   | 5.000E+01 | 5.000E+01 |               ---                | DCNUCC( 5)
R016 |   Unsaturated zone 1 (cm**3/g)                  | 5.000E+01 | 5.000E+01 |               ---                | DCNUCU( 5,1)
R016 |   Saturated zone (cm**3/g)                      | 5.000E+01 | 5.000E+01 |               ---                | DCNUCS( 5)
R016 |   Leach rate (/yr)                              | 0.000E+00 | 0.000E+00 |            2.392E-03             | ALEACH( 5)
R016 |   Solubility constant                           | 0.000E+00 | 0.000E+00 |            not used              | SOLUBK( 5)
     |                                                 |           |           |                                  |
R016 | Distribution coefficients for U-238             |           |           |                                  |
R016 |   Contaminated zone (cm**3/g)                   | 5.000E+01 | 5.000E+01 |               ---                | DCNUCC( 6)
R016 |   Unsaturated zone 1 (cm**3/g)                  | 5.000E+01 | 5.000E+01 |               ---                | DCNUCU( 6,1)
R016 |   Saturated zone (cm**3/g)                      | 5.000E+01 | 5.000E+01 |               ---                | DCNUCS( 6)
R016 |   Leach rate (/yr)                              | 0.000E+00 | 0.000E+00 |            2.392E-03             | ALEACH( 6)
R016 |   Solubility constant                           | 0.000E+00 | 0.000E+00 |            not used              | SOLUBK( 6)
```

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                                   Site-Specific Parameter Summary (continued)

     |                                                         |   User    |           |     Used by RESRAD                | Parameter
Menu |                     Parameter                           |   Input   |  Default  | (If different from user input)    |   Name
-----+---------------------------------------------------------+-----------+-----------+-----------------------------------+----------------
R016 | Distribution coefficients for daughter Ra-226           |           |           |                                   |
R016 |   Contaminated zone (cm**3/g)                           | 7.000E+01 | 7.000E+01 |          ---                      | DCNUCC( 3)
R016 |   Unsaturated zone 1 (cm**3/g)                          | 7.000E+01 | 7.000E+01 |          ---                      | DCNUCU( 3,1)
R016 |   Saturated zone (cm**3/g)                              | 7.000E+01 | 7.000E+01 |          ---                      | DCNUCS( 3)
R016 |   Leach rate (/yr)                                      | 0.000E+00 | 0.000E+00 |       1.710E-03                   | ALEACH( 3)
R016 |   Solubility constant                                   | 0.000E+00 | 0.000E+00 |       not used                    | SOLUBK( 3)
     |                                                         |           |           |                                   |
R017 | Inhalation rate (m**3/yr)                               | 7.300E+03 | 8.400E+03 |          ---                      | INHALR
R017 | Mass loading for inhalation (g/m**3)                    | 1.000E-04 | 1.000E-04 |          ---                      | MLINH
R017 | Exposure duration                                       | 3.000E+01 | 3.000E+01 |          ---                      | ED
R017 | Shielding factor, inhalation                            | 4.000E-01 | 4.000E-01 |          ---                      | SHF3
R017 | Shielding factor, external gamma                        | 7.000E-01 | 7.000E-01 |          ---                      | SHF1
R017 | Fraction of time spent indoors                          | 5.000E-01 | 5.000E-01 |          ---                      | FIND
R017 | Fraction of time spent outdoors (on site)               | 2.500E-01 | 2.500E-01 |          ---                      | FOTD
R017 | Shape factor flag, external gamma                       | 1.000E+00 | 1.000E+00 | >0 shows circular AREA.           | FS
R017 | Radii of shape factor array (used if FS = -1):          |           |           |                                   |
R017 |   Outer annular radius (m), ring  1:                    | not used  | 5.000E+01 |          ---                      | RAD_SHAPE( 1)
R017 |   Outer annular radius (m), ring  2:                    | not used  | 7.071E+01 |          ---                      | RAD_SHAPE( 2)
R017 |   Outer annular radius (m), ring  3:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE( 3)
R017 |   Outer annular radius (m), ring  4:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE( 4)
R017 |   Outer annular radius (m), ring  5:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE( 5)
R017 |   Outer annular radius (m), ring  6:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE( 6)
R017 |   Outer annular radius (m), ring  7:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE( 7)
R017 |   Outer annular radius (m), ring  8:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE( 8)
R017 |   Outer annular radius (m), ring  9:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE( 9)
R017 |   Outer annular radius (m), ring 10:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE(10)
R017 |   Outer annular radius (m), ring 11:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE(11)
R017 |   Outer annular radius (m), ring 12:                    | not used  | 0.000E+00 |          ---                      | RAD_SHAPE(12)
     |                                                         |           |           |                                   |
R017 | Fractions of annular areas within AREA:                 |           |           |                                   |
R017 |   Ring  1                                               | not used  | 1.000E+00 |          ---                      | FRACA( 1)
R017 |   Ring  2                                               | not used  | 2.732E-01 |          ---                      | FRACA( 2)
R017 |   Ring  3                                               | not used  | 0.000E+00 |          ---                      | FRACA( 3)
R017 |   Ring  4                                               | not used  | 0.000E+00 |          ---                      | FRACA( 4)
R017 |   Ring  5                                               | not used  | 0.000E+00 |          ---                      | FRACA( 5)
R017 |   Ring  6                                               | not used  | 0.000E+00 |          ---                      | FRACA( 6)
R017 |   Ring  7                                               | not used  | 0.000E+00 |          ---                      | FRACA( 7)
R017 |   Ring  8                                               | not used  | 0.000E+00 |          ---                      | FRACA( 8)
R017 |   Ring  9                                               | not used  | 0.000E+00 |          ---                      | FRACA( 9)
R017 |   Ring 10                                               | not used  | 0.000E+00 |          ---                      | FRACA(10)
R017 |   Ring 11                                               | not used  | 0.000E+00 |          ---                      | FRACA(11)
R017 |   Ring 12                                               | not used  | 0.000E+00 |          ---                      | FRACA(12)
     |                                                         |           |           |                                   |
R018 | Fruits, vegetables and grain consumption (kg/yr)        | not used  | 1.600E+02 |          ---                      | DIET(1)
R018 | Leafy vegetable consumption (kg/yr)                     | not used  | 1.400E+01 |          ---                      | DIET(2)
R018 | Milk consumption (L/yr)                                 | not used  | 9.200E+01 |          ---                      | DIET(3)
R018 | Meat and poultry consumption (kg/yr)                    | not used  | 6.300E+01 |          ---                      | DIET(4)
R018 | Fish consumption (kg/yr)                                | not used  | 5.400E+00 |          ---                      | DIET(5)
R018 | Other seafood consumption (kg/yr)                       | not used  | 9.000E-01 |          ---                      | DIET(6)
R018 | Soil ingestion rate (g/yr)                              | 3.650E+01 | 3.650E+01 |          ---                      | SOIL
R018 | Drinking water intake (L/yr)                            | 7.000E+02 | 5.100E+02 |          ---                      | DWI
```

```
                              Site-Specific Parameter Summary (continued)

     |                                                 |   User     |            |         Used by RESRAD          | Parameter
Menu |                  Parameter                      |   Input    |  Default   | (If different from user input)  |   Name
-----+-------------------------------------------------+------------+------------+---------------------------------+-----------
R018 | Contamination fraction of drinking water        | 1.000E+00  | 1.000E+00  |              ---                | FDW
R018 | Contamination fraction of household water       | not used   | 1.000E+00  |              ---                | FHHW
R018 | Contamination fraction of livestock water       | not used   | 1.000E+00  |              ---                | FLW
R018 | Contamination fraction of irrigation water      | not used   | 1.000E+00  |              ---                | FIRW
R018 | Contamination fraction of aquatic food          | not used   | 5.000E-01  |              ---                | FR9
R018 | Contamination fraction of plant food            | not used   |-1          |              ---                | FPLANT
R018 | Contamination fraction of meat                  | not used   |-1          |              ---                | FMEAT
R018 | Contamination fraction of milk                  | not used   |-1          |              ---                | FMILK
     |                                                 |            |            |                                 |
R019 | Livestock fodder intake for meat (kg/day)       | not used   | 6.800E+01  |              ---                | LFI5
R019 | Livestock fodder intake for milk (kg/day)       | not used   | 5.500E+01  |              ---                | LFI6
R019 | Livestock water intake for meat (L/day)         | not used   | 5.000E+01  |              ---                | LWI5
R019 | Livestock water intake for milk (L/day)         | not used   | 1.600E+02  |              ---                | LWI6
R019 | Livestock soil intake (kg/day)                  | not used   | 5.000E-01  |              ---                | LSI
R019 | Mass loading for foliar deposition (g/m**3)     | not used   | 1.000E-04  |              ---                | MLFD
R019 | Depth of soil mixing layer (m)                  | 1.500E-01  | 1.500E-01  |              ---                | DM
R019 | Depth of roots (m)                              | not used   | 9.000E-01  |              ---                | DROOT
R019 | Drinking water fraction from ground water       | 1.000E+00  | 1.000E+00  |              ---                | FGWDW
R019 | Household water fraction from ground water      | 1.000E+00  | 1.000E+00  |              ---                | FGWHH
R019 | Livestock water fraction from ground water      | not used   | 1.000E+00  |              ---                | FGWLW
R019 | Irrigation fraction from ground water           | not used   | 1.000E+00  |              ---                | FGWIR
     |                                                 |            |            |                                 |
R19B | Wet weight crop yield for Non-Leafy (kg/m**2)   | not used   | 7.000E-01  |              ---                | YV(1)
R19B | Wet weight crop yield for Leafy     (kg/m**2)   | not used   | 1.500E+00  |              ---                | YV(2)
R19B | Wet weight crop yield for Fodder    (kg/m**2)   | not used   | 1.100E+00  |              ---                | YV(3)
R19B | Growing Season for  Non-Leafy (years)           | not used   | 1.700E-01  |              ---                | TE(1)
R19B | Growing Season for  Leafy     (years)           | not used   | 2.500E-01  |              ---                | TE(2)
R19B | Growing Season for  Fodder    (years)           | not used   | 8.000E-02  |              ---                | TE(3)
R19B | Translocation Factor for  Non-Leafy             | not used   | 1.000E-01  |              ---                | TIV(1)
R19B | Translocation Factor for  Leafy                 | not used   | 1.000E+00  |              ---                | TIV(2)
R19B | Translocation Factor for  Fodder                | not used   | 1.000E+00  |              ---                | TIV(3)
R19B | Dry Foliar Interception Fraction for  Non-Leafy | not used   | 2.500E-01  |              ---                | RDRY(1)
R19B | Dry Foliar Interception Fraction for  Leafy     | not used   | 2.500E-01  |              ---                | RDRY(2)
R19B | Dry Foliar Interception Fraction for  Fodder    | not used   | 2.500E-01  |              ---                | RDRY(3)
R19B | Wet Foliar Interception Fraction for  Non-Leafy | not used   | 2.500E-01  |              ---                | RWET(1)
R19B | Wet Foliar Interception Fraction for  Leafy     | not used   | 2.500E-01  |              ---                | RWET(2)
R19B | Wet Foliar Interception Fraction for  Fodder    | not used   | 2.500E-01  |              ---                | RWET(3)
R19B | Weathering Removal Constant for Vegetation      | not used   | 2.000E+01  |              ---                | WLAM
     |                                                 |            |            |                                 |
C14  | C-12 concentration in water (g/cm**3)           | not used   | 2.000E-05  |              ---                | C12WTR
C14  | C-12 concentration in contaminated soil (g/g)   | not used   | 3.000E-02  |              ---                | C12CZ
C14  | Fraction of vegetation carbon from soil         | not used   | 2.000E-02  |              ---                | CSOIL
C14  | Fraction of vegetation carbon from air          | not used   | 9.800E-01  |              ---                | CAIR
C14  | C-14 evasion layer thickness in soil (m)        | not used   | 3.000E-01  |              ---                | DMC
C14  | C-14 evasion flux rate from soil (1/sec)        | not used   | 7.000E-07  |              ---                | EVSN
C14  | C-12 evasion flux rate from soil (1/sec)        | not used   | 1.000E-10  |              ---                | REVSN
C14  | Fraction of grain in beef cattle feed           | not used   | 8.000E-01  |              ---                | AVFG4
C14  | Fraction of grain in milk cow feed              | not used   | 2.000E-01  |              ---                | AVFG5
     |                                                 |            |            |                                 |
STOR | Storage times of contaminated foodstuffs (days):|            |            |                                 |
STOR |   Fruits, non-leafy vegetables, and grain       | 1.400E+01  | 1.400E+01  |              ---                | STOR_T(1)
```

```
                                         Site-Specific Parameter Summary (continued)

     |                                                  |    User    |            |            Used by RESRAD            |   Parameter
Menu |                    Parameter                     |    Input   |   Default  |  (If different from user input)      |     Name
---------------------------------------------------------------------------------------------------------------------------------------
STOR |     Leafy vegetables                             | 1.000E+00  | 1.000E+00  |                 ---                  | STOR T(2)
STOR |     Milk                                         | 1.000E+00  | 1.000E+00  |                 ---                  | STOR T(3)
STOR |     Meat and poultry                             | 2.000E+01  | 2.000E+01  |                 ---                  | STOR T(4)
STOR |     Fish                                         | 7.000E+00  | 7.000E+00  |                 ---                  | STOR T(5)
STOR |     Crustacea and mollusks                       | 7.000E+00  | 7.000E+00  |                 ---                  | STOR T(6)
STOR |     Well water                                   | 1.000E+00  | 1.000E+00  |                 ---                  | STOR T(7)
STOR |     Surface water                                | 1.000E+00  | 1.000E+00  |                 ---                  | STOR T(8)
STOR |     Livestock fodder                             | 4.500E+01  | 4.500E+01  |                 ---                  | STOR_T(9)
     |                                                  |            |            |                                      |
R021 |   Thickness of building foundation (m)           | not used   | 1.500E-01  |                 ---                  | FLOOR
R021 |   Bulk density of building foundation (g/cm**3)  | not used   | 2.400E+00  |                 ---                  | DENSFL
R021 |   Total porosity of the cover material           | not used   | 4.000E-01  |                 ---                  | TPCV
R021 |   Total porosity of the building foundation      | not used   | 1.000E-01  |                 ---                  | TPFL
R021 |   Volumetric water content of the cover material | not used   | 5.000E-02  |                 ---                  | PH2OCV
R021 |   Volumetric water content of the foundation     | not used   | 3.000E-02  |                 ---                  | PH2OFL
R021 |   Diffusion coefficient for radon gas (m/sec):   |            |            |                                      |
R021 |     in cover material                            | not used   | 2.000E-06  |                 ---                  | DIFCV
R021 |     in foundation material                       | not used   | 3.000E-07  |                 ---                  | DIFFL
R021 |     in contaminated zone soil                    | not used   | 2.000E-06  |                 ---                  | DIFCZ
R021 |   Radon vertical dimension of mixing (m)         | not used   | 2.000E+00  |                 ---                  | HMIX
R021 |   Average building air exchange rate (1/hr)      | not used   | 5.000E-01  |                 ---                  | REXG
R021 |   Height of the building (room) (m)              | not used   | 2.500E+00  |                 ---                  | HRM
R021 |   Building interior area factor                  | not used   | 0.000E+00  |                 ---                  | FAI
R021 |   Building depth below ground surface (m)        | not used   |-1.000E+00  |                 ---                  | DMFL
R021 |   Emanating power of Rn-222 gas                  | not used   | 2.500E-01  |                 ---                  | EMANA(1)
R021 |   Emanating power of Rn-220 gas                  | not used   | 1.500E-01  |                 ---                  | EMANA(2)
=======================================================================================================================================


                     Summary of Pathway Selections

                  Pathway              |  User Selection
          --------------------------------------------------
             1 -- external gamma       |     active
             2 -- inhalation (w/o radon)|    active
             3 -- plant ingestion      |   suppressed
             4 -- meat ingestion       |   suppressed
             5 -- milk ingestion       |   suppressed
             6 -- aquatic foods        |   suppressed
             7 -- drinking water       |     active
             8 -- soil ingestion       |     active
             9 -- radon                |   suppressed
             Find peak pathway doses   |   suppressed
          ==================================================
```

```
     Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
     ____________________________            __________________________________

        Area:  65000.00 square meters               Cs-137      1.500E+00
   Thickness:      1.00 meters                      Pb-210      9.100E+00
 Cover Depth:      0.00 meters                      Th-230      2.200E+00
                                                    U-234       1.300E+00
                                                    U-238       1.400E+00


                                      Total Dose TDOSE(t), mrem/yr
                                 Basic Radiation Dose Limit =  10 mrem/yr
                   Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                   __________________________________________________________________________

    t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
     TDOSE(t):  5.055E+00  4.933E+00  4.482E+00  3.985E+00  2.863E+00  2.140E+00  1.681E+00  1.397E+00
         M(t):  5.055E-01  4.933E-01  4.482E-01  3.985E-01  2.863E-01  2.140E-01  1.681E-01  1.397E-01

Maximum TDOSE(t):  5.055E+00 mrem/yr   at t = 0.000E+00 years
```

```
                                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                    As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                        Water Independent Pathways (Inhalation excludes radon)

                 Ground              Inhalation             Radon                 Plant                 Meat                  Milk                  Soil
Radio-    --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
Nuclide   mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------   ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------
Cs-137    2.967E+00  0.5870     2.799E-06  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.053E-03  0.0004
Pb-210    3.320E-02  0.0066     1.235E-02  0.0024     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.811E+00  0.3583
Th-230    1.575E-03  0.0003     4.196E-02  0.0083     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     3.300E-02  0.0065
U-234     3.104E-04  0.0001     1.004E-02  0.0020     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.007E-02  0.0020
U-238     1.118E-01  0.0221     9.665E-03  0.0019     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.031E-02  0.0020
=======   =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======
Total     3.114E+00  0.6161     7.402E-02  0.0146     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.866E+00  0.3693


                                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                    As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                                       Water Dependent Pathways

                  Water                 Fish                 Radon                 Plant                 Meat                  Milk             All Pathways*
Radio-    --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
Nuclide   mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------   ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------
Cs-137    0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.969E+00  0.5874
Pb-210    0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.857E+00  0.3673
Th-230    0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     7.654E-02  0.0151
U-234     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.042E-02  0.0040
U-238     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.318E-01  0.0261
=======   =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======
Total     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     5.055E+00  1.0000

*Sum of all water independent and dependent pathways.
```

```
                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                             As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                               Water Independent Pathways (Inhalation excludes radon)

             Ground           Inhalation          Radon              Plant              Meat               Milk               Soil
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  2.899E+00 0.5876  2.735E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.006E-03 0.0004
Pb-210  3.215E-02 0.0065  1.196E-02 0.0024  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.754E+00 0.3554
Th-230  7.777E-03 0.0016  4.196E-02 0.0085  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.304E-02 0.0067
U-234   3.097E-04 0.0001  1.002E-02 0.0020  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.005E-02 0.0020
U-238   1.116E-01 0.0226  9.642E-03 0.0020  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.028E-02 0.0021
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   3.051E+00 0.6184  7.358E-02 0.0149  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.809E+00 0.3667

                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                             As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                               Water Dependent Pathways

             Water             Fish              Radon              Plant              Meat               Milk          All Pathways*
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.901E+00 0.5881
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.798E+00 0.3644
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.278E-02 0.0168
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.037E-02 0.0041
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.315E-01 0.0267
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.933E+00 1.0000

*Sum of all water independent and dependent pathways.
```

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                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                         Water Independent Pathways (Inhalation excludes radon)

             Ground            Inhalation            Radon              Plant              Meat               Milk               Soil
Radio-  ----------------   ----------------   ----------------   ----------------   ----------------   ----------------   ----------------
Nuclide  mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.
------- --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  2.642E+00 0.5895   2.492E-06 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.828E-03 0.0004
Pb-210  2.826E-02 0.0063   1.051E-02 0.0023   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.541E+00 0.3439
Th-230  3.245E-02 0.0072   4.196E-02 0.0094   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.324E-02 0.0074
U-234   3.072E-04 0.0001   9.921E-03 0.0022   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.952E-03 0.0022
U-238   1.105E-01 0.0247   9.550E-03 0.0021   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.019E-02 0.0023
======= ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total   2.813E+00 0.6278   7.194E-02 0.0161   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.596E+00 0.3562

                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                         Water Dependent Pathways

             Water               Fish              Radon              Plant              Meat               Milk          All Pathways*
Radio-  ----------------   ----------------   ----------------   ----------------   ----------------   ----------------   ----------------
Nuclide  mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.    mrem/yr  fract.
------- --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Cs-137  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.644E+00 0.5899
Pb-210  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.580E+00 0.3525
Th-230  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.077E-01 0.0240
U-234   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.018E-02 0.0045
U-238   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.302E-01 0.0291
======= ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.482E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                                Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                   Water Independent Pathways (Inhalation excludes radon)

            Ground              Inhalation              Radon                Plant                 Meat                 Milk                 Soil
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137   2.352E+00 0.5902   2.219E-06 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.628E-03 0.0004
Pb-210   2.404E-02 0.0060   8.944E-03 0.0022   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.311E+00 0.3290
Th-230   6.300E-02 0.0158   4.196E-02 0.0105   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.361E-02 0.0084
U-234    3.048E-04 0.0001   9.804E-03 0.0025   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.835E-03 0.0025
U-238    1.092E-01 0.0274   9.437E-03 0.0024   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.007E-02 0.0025
=======  ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total    2.549E+00 0.6395   7.015E-02 0.0176   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.367E+00 0.3429

                                Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                                  Water Dependent Pathways

             Water                 Fish                Radon                Plant                 Meat                 Milk           All Pathways*
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.354E+00 0.5906
Pb-210   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.344E+00 0.3373
Th-230   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.386E-01 0.0348
U-234    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.994E-02 0.0050
U-238    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.287E-01 0.0323
=======  ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.985E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                              As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                     Water Independent Pathways (Inhalation excludes radon)

              Ground            Inhalation            Radon               Plant               Meat                Milk                Soil
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Cs-137   1.660E+00 0.5799    1.566E-06 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.149E-03 0.0004
Pb-210   1.482E-02 0.0052    5.511E-03 0.0019    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.081E-01 0.2822
Th-230   1.527E-01 0.0533    4.197E-02 0.0147    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.524E-02 0.0123
U-234    3.025E-04 0.0001    9.461E-03 0.0033    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.490E-03 0.0033
U-238    1.053E-01 0.0368    9.104E-03 0.0032    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.712E-03 0.0034
=======  ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total    1.933E+00 0.6753    6.605E-02 0.0231    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.637E-01 0.3016


                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                              As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                   Water Dependent Pathways

              Water               Fish                Radon               Plant               Meat                Milk           All Pathways*
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Cs-137   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.661E+00 0.5803
Pb-210   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.284E-01 0.2893
Th-230   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.299E-01 0.0803
U-234    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.925E-02 0.0067
U-238    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.242E-01 0.0434
=======  ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.863E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                              Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                             As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                                 Water Independent Pathways (Inhalation excludes radon)

                 Ground              Inhalation              Radon                 Plant                  Meat                  Milk                  Soil
Radio-    --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
Nuclide    mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------   ---------  -------    ---------  -------    ---------  -------    ---------  -------    ---------  -------    ---------  -------    ---------  -------
Cs-137    1.172E+00  0.5475     1.106E-06  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     8.109E-04  0.0004
Pb-210    9.129E-03  0.0043     3.396E-03  0.0016     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     4.979E-01  0.2326
Th-230    2.396E-01  0.1119     4.198E-02  0.0196     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     3.742E-02  0.0175
-234      3.073E-04  0.0001     9.131E-03  0.0043     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     9.158E-03  0.0043
-238      1.016E-01  0.0475     8.784E-03  0.0041     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     9.370E-03  0.0044
=======   =========  =======    =========  =======    =========  =======    =========  =======    =========  =======    =========  =======    =========  =======
Total     1.523E+00  0.7113     6.329E-02  0.0296     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     5.547E-01  0.2591

                              Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                             As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                                              Water Dependent Pathways

                  Water                 Fish                 Radon                 Plant                  Meat                  Milk             All Pathways*
adio-     --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
uclide     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------   ---------  -------    ---------  -------    ---------  -------    ---------  -------    ---------  -------    ---------  -------    ---------  -------
s-137     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.173E+00  0.5479
b-210     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     5.104E-01  0.2385
h-230     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     3.190E-01  0.1490
-234      0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.860E-02  0.0087
-238      0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.198E-01  0.0560
=======   =========  =======    =========  =======    =========  =======    =========  =======    =========  =======    =========  =======    =========  =======
otal      0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.140E+00  1.0000
 Sum of all water independent and dependent pathways.
```

```
                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                       As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                          Water Independent Pathways (Inhalation excludes radon)

              Ground             Inhalation             Radon                Plant                 Meat                 Milk                 Soil
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137   8.272E-01 0.4920   7.804E-07 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   5.723E-04 0.0003
Pb-210   5.625E-03 0.0033   2.092E-03 0.0012   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.068E-01 0.1825
Th-230   3.237E-01 0.1925   4.199E-02 0.0250   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.990E-02 0.0237
U-234    3.185E-04 0.0002   8.812E-03 0.0052   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.838E-03 0.0053
U-238    9.804E-02 0.0583   8.475E-03 0.0050   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.040E-03 0.0054
=======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total    1.255E+00 0.7463   6.137E-02 0.0365   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.652E-01 0.2172

                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                       As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                         Water Dependent Pathways

              Water                Fish                Radon                Plant                 Meat                 Milk            All Pathways*
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Cs-137   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.277E-01 0.4923
Pb-210   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.145E-01 0.1871
Th-230   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.056E-01 0.2412
U-234    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.797E-02 0.0107
U-238    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.156E-01 0.0687
=======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.681E+00 1.0000

*Sum of all water independent and dependent pathways.
```

```
                            Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                         As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                Water Independent Pathways (Inhalation excludes radon)

              Ground              Inhalation              Radon                 Plant                 Meat                  Milk                  Soil
Radio-   -------------------   -------------------   -------------------   -------------------   -------------------   -------------------   -------------------
Nuclide  mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------
Cs-137   5.838E-01 0.4181   5.508E-07 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.040E-04 0.0003
Pb-210   3.466E-03 0.0025   1.289E-03 0.0009   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.890E-01 0.1354
Th-230   4.051E-01 0.2901   4.201E-02 0.0301   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.252E-02 0.0304
U-234    3.359E-04 0.0002   8.504E-03 0.0061   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.530E-03 0.0061
U-238    9.459E-02 0.0677   8.176E-03 0.0059   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.722E-03 0.0062
=======  ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total    1.087E+00 0.7786   5.998E-02 0.0429   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.492E-01 0.1785


                            Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                         As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                          Water Dependent Pathways

              Water                 Fish                 Radon                 Plant                 Meat                  Milk             All Pathways*
Radio-   -------------------   -------------------   -------------------   -------------------   -------------------   -------------------   -------------------
Nuclide  mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------
Cs-137   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   5.842E-01 0.4184
Pb-210   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.938E-01 0.1388
Th-230   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.896E-01 0.3506
U-234    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.737E-02 0.0124
U-238    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.115E-01 0.0798
=======  ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.397E+00 1.0000

*Sum of all water independent and dependent pathways.
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                                     Dose/Source Ratios Summed Over All Pathways
                          Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                                    DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)       (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
-------  -------  ---------    --------- --------- --------- --------- --------- --------- --------- ---------
Cs-137   Cs-137   1.000E+00    1.979E+00 1.934E+00 1.762E+00 1.569E+00 1.108E+00 7.818E-01 5.518E-01 3.895E-01

Pb-210   Pb-210   1.000E+00    2.040E-01 1.975E-01 1.736E-01 1.477E-01 9.103E-02 5.609E-02 3.456E-02 2.130E-02

Th-230   Th-230   1.000E+00    3.479E-02 3.479E-02 3.479E-02 3.479E-02 3.478E-02 3.477E-02 3.477E-02 3.476E-02
Th-230   Ra-226   1.000E+00    0.000E+00 2.835E-03 1.411E-02 2.808E-02 6.907E-02 1.088E-01 1.472E-01 1.844E-01
Th-230   Pb-210   1.000E+00    0.000E+00 1.358E-06 3.245E-05 1.228E-04 6.550E-04 1.447E-03 2.383E-03 3.395E-03
Th-230   ∑DSR(j)               3.479E-02 3.763E-02 4.893E-02 6.298E-02 1.045E-01 1.450E-01 1.843E-01 2.226E-01

U-234    U-234    1.000E+00    1.571E-02 1.567E-02 1.552E-02 1.534E-02 1.480E-02 1.427E-02 1.377E-02 1.328E-02
U-234    Th-230   1.000E+00    0.000E+00 3.128E-07 1.556E-06 3.094E-06 7.598E-06 1.194E-05 1.613E-05 2.017E-05
U-234    Ra-226   1.000E+00    0.000E+00 1.275E-08 3.169E-07 1.258E-06 7.687E-06 1.924E-05 3.556E-05 5.633E-05
U-234    Pb-210   1.000E+00    0.000E+00 4.084E-12 4.923E-10 3.766E-09 5.171E-08 1.874E-07 4.341E-07 8.018E-07
U-234    ∑DSR(j)               1.571E-02 1.567E-02 1.552E-02 1.534E-02 1.481E-02 1.430E-02 1.382E-02 1.336E-02

U-238    U-238    1.000E+00    9.415E-02 9.392E-02 9.303E-02 9.192E-02 8.868E-02 8.556E-02 8.254E-02 7.963E-02
U-238    U-234    1.000E+00    0.000E+00 4.443E-08 2.200E-07 4.348E-07 1.049E-06 1.619E-06 2.147E-06 2.636E-06
U-238    Th-230   1.000E+00    0.000E+00 4.432E-13 1.101E-11 4.369E-11 2.666E-10 6.664E-10 1.230E-09 1.946E-09
U-238    Ra-226   1.000E+00    0.000E+00 1.205E-14 1.496E-12 1.186E-11 1.806E-10 7.208E-10 1.826E-09 3.669E-09
U-238    Pb-210   1.000E+00    0.000E+00 2.891E-18 1.756E-15 2.704E-14 9.450E-13 5.567E-12 1.797E-11 4.277E-11
U-238    ∑DSR(j)               9.415E-02 9.392E-02 9.303E-02 9.192E-02 8.868E-02 8.556E-02 8.254E-02 7.963E-02
=======  =======  =========    ========= ========= ========= ========= ========= ========= ========= =========
*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.


                                 Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                                      Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)     t= 0.000E+00    1.000E+00    5.000E+00    1.000E+01    2.500E+01    4.000E+01    5.500E+01    7.000E+01
-------      ---------    ---------    ---------    ---------    ---------    ---------    ---------    ---------
Cs-137       5.052E+00    5.171E+00    5.674E+00    6.373E+00    9.028E+00    1.279E+01    1.812E+01    2.567E+01
Pb-210       4.901E+01    5.062E+01    5.760E+01    6.769E+01    1.099E+02    1.783E+02    2.893E+02    4.695E+02
Th-230       2.874E+02    2.658E+02    2.044E+02    1.588E+02    9.569E+01    6.897E+01    5.425E+01    4.493E+01
U-234        6.366E+02    6.381E+02    6.442E+02    6.519E+02    6.752E+02    6.991E+02    7.235E+02    7.484E+02
U-238        1.062E+02    1.065E+02    1.075E+02    1.088E+02    1.128E+02    1.169E+02    1.212E+02    1.256E+02
=======      =========    =========    =========    =========    =========    =========    =========    =========
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              Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
              and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
           at tmin = time of minimum single radionuclide soil guideline
       and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide  Initial         tmin        DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
  (i)     pCi/g        (years)                    (pCi/g)              (pCi/g)
_______ _________  ______________     _________  _________  _________  _________

Cs-137  1.500E+00     0.000E+00       1.979E+00  5.052E+00  1.979E+00  5.052E+00
Pb-210  9.100E+00     0.000E+00       2.040E-01  4.901E+01  2.040E-01  4.901E+01
Th-230  2.200E+00     7.000E+01       2.226E-01  4.493E+01  3.479E-02  2.874E+02
U-234   1.300E+00     0.000E+00       1.571E-02  6.366E+02  1.571E-02  6.366E+02
U-238   1.400E+00     0.000E+00       9.415E-02  1.062E+02  9.415E-02  1.062E+02
=======  =========  ==============     =========  =========  =========  =========
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                                            Individual Nuclide Dose Summed Over All Pathways
                                              Parent Nuclide and Branch Fraction Indicated

Nuclide  Parent     BRF(i)                                         DOSE(j,t), mrem/yr
  (j)      (i)                  t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
-------- --------  ---------       --------- --------- --------- --------- --------- --------- --------- ---------
Cs-137   Cs-137    1.000E+00       2.969E+00 2.901E+00 2.644E+00 2.354E+00 1.661E+00 1.173E+00 8.277E-01 5.842E-01

Pb-210   Pb-210    1.000E+00       1.857E+00 1.798E+00 1.580E+00 1.344E+00 8.284E-01 5.104E-01 3.145E-01 1.938E-01
Pb-210   Th-230    1.000E+00       0.000E+00 2.988E-06 7.138E-05 2.702E-04 1.441E-03 3.183E-03 5.243E-03 7.470E-03
Pb-210   U-234     1.000E+00       0.000E+00 5.309E-12 6.399E-10 4.896E-09 6.722E-08 2.437E-07 5.643E-07 1.042E-06
Pb-210   U-238     1.000E+00       0.000E+00 4.047E-18 2.459E-15 3.786E-14 1.323E-12 7.794E-12 2.516E-11 5.987E-11
Pb-210   ∑DOSE(j):                 1.857E+00 1.798E+00 1.580E+00 1.345E+00 8.298E-01 5.136E-01 3.198E-01 2.013E-01

Th-230   Th-230    1.000E+00       7.654E-02 7.654E-02 7.653E-02 7.653E-02 7.652E-02 7.650E-02 7.649E-02 7.648E-02
Th-230   U-234     1.000E+00       0.000E+00 4.066E-07 2.023E-06 4.023E-06 9.878E-06 1.553E-05 2.097E-05 2.623E-05
Th-230   U-238     1.000E+00       0.000E+00 6.205E-13 1.541E-11 6.116E-11 3.732E-10 9.330E-10 1.722E-09 2.725E-09
Th-230   ∑DOSE(j):                 7.654E-02 7.654E-02 7.653E-02 7.653E-02 7.653E-02 7.652E-02 7.651E-02 7.650E-02

Ra-226   Th-230    1.000E+00       0.000E+00 6.237E-03 3.105E-02 6.177E-02 1.520E-01 2.393E-01 3.238E-01 4.057E-01
Ra-226   U-234     1.000E+00       0.000E+00 1.658E-08 4.120E-07 1.636E-06 9.993E-06 2.501E-05 4.623E-05 7.322E-05
Ra-226   U-238     1.000E+00       0.000E+00 1.687E-14 2.094E-12 1.661E-11 2.529E-10 1.009E-09 2.556E-09 5.136E-09
Ra-226   ∑DOSE(j):                 0.000E+00 6.237E-03 3.105E-02 6.177E-02 1.520E-01 2.393E-01 3.239E-01 4.058E-01

U-234    U-234     1.000E+00       2.042E-02 2.037E-02 2.018E-02 1.994E-02 1.923E-02 1.856E-02 1.790E-02 1.727E-02
U-234    U-238     1.000E+00       0.000E+00 6.220E-08 3.080E-07 6.087E-07 1.468E-06 2.266E-06 3.006E-06 3.691E-06
U-234    ∑DOSE(j):                 2.042E-02 2.037E-02 2.018E-02 1.994E-02 1.924E-02 1.856E-02 1.790E-02 1.727E-02

U-238    U-238     1.000E+00       1.318E-01 1.315E-01 1.302E-01 1.287E-01 1.242E-01 1.198E-01 1.156E-01 1.115E-01
======== ========  =========       ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
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                              Individual Nuclide Soil Concentration
                          Parent Nuclide and Branch Fraction Indicated

uclide  Parent    BRF(i)                                           S(j,t), pCi/g
 (j)     (i)                t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ _______ __________     _________ _________ _________ _________ _________ _________ _________ _________

s-137   Cs-137  1.000E+00      1.500E+00 1.466E+00 1.336E+00 1.189E+00 8.393E-01 5.924E-01 4.182E-01 2.951E-01

b-210   Pb-210  1.000E+00      9.100E+00 8.811E+00 7.744E+00 6.589E+00 4.060E+00 2.502E+00 1.542E+00 9.499E-01
b-210   Th-230  1.000E+00      0.000E+00 1.464E-05 3.499E-04 1.324E-03 7.063E-03 1.560E-02 2.570E-02 3.661E-02
b-210   U-234   1.000E+00      0.000E+00 2.602E-11 3.137E-09 2.400E-08 3.295E-07 1.194E-06 2.766E-06 5.109E-06
b-210   U-238   1.000E+00      0.000E+00 1.983E-17 1.205E-14 1.856E-13 6.484E-12 3.820E-11 1.233E-10 2.935E-10
b-210   ∑S(j):                 9.100E+00 8.811E+00 7.744E+00 6.591E+00 4.067E+00 2.517E+00 1.567E+00 9.865E-01

h-230   Th-230  1.000E+00      2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00 2.198E+00
h-230   U-234   1.000E+00      0.000E+00 1.169E-05 5.816E-05 1.156E-04 2.839E-04 4.463E-04 6.029E-04 7.539E-04
h-230   U-238   1.000E+00      0.000E+00 1.784E-11 4.430E-10 1.758E-09 1.073E-08 2.682E-08 4.951E-08 7.832E-08
h-230   ∑S(j):                 2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.200E+00 2.199E+00 2.199E+00 2.199E+00

a-226   Th-230  1.000E+00      0.000E+00 9.521E-04 4.740E-03 9.429E-03 2.320E-02 3.653E-02 4.943E-02 6.193E-02
a-226   U-234   1.000E+00      0.000E+00 2.531E-09 6.289E-08 2.497E-07 1.525E-06 3.818E-06 7.057E-06 1.118E-05
a-226   U-238   1.000E+00      0.000E+00 2.575E-15 3.197E-13 2.535E-12 3.860E-11 1.541E-10 3.902E-10 7.840E-10
a-226   ∑S(j):                 0.000E+00 9.521E-04 4.740E-03 9.429E-03 2.320E-02 3.653E-02 4.944E-02 6.194E-02

-234    U-234   1.000E+00      1.300E+00 1.297E+00 1.285E+00 1.269E+00 1.224E+00 1.181E+00 1.140E+00 1.099E+00
-234    U-238   1.000E+00      0.000E+00 3.959E-06 1.961E-05 3.875E-05 9.346E-05 1.443E-04 1.914E-04 2.350E-04
-234    ∑S(j):                 1.300E+00 1.297E+00 1.285E+00 1.269E+00 1.225E+00 1.181E+00 1.140E+00 1.100E+00

-238    U-238   1.000E+00      1.400E+00 1.397E+00 1.383E+00 1.367E+00 1.319E+00 1.272E+00 1.227E+00 1.184E+00
======= ======= ==========     ========= ========= ========= ========= ========= ========= ========= =========
RF(i) is the branch fraction of the parent nuclide.
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RESRAD OUTPUT FOR CONSTRUCTION WORKER – SOIL SUPPORT FOR DERIVATION OF CLEAN UP GOAL

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

```
                              Dose Conversion Factor (and Related) Parameter Summary
                                                 File: DOSFAC.BIN

     |                                                            | Current   |           | Parameter
Menu |                         Parameter                          |  Value    |  Default  |  Name
-----+------------------------------------------------------------+-----------+-----------+------------
B-1  | Dose conversion factors for inhalation, mrem/pCi:          |           |           |
B-1  | Ac-227+D                                                   | 6.720E+00 | 6.720E+00 | DCF2( 1)
B-1  | Co-57                                                      | 9.070E-06 | 9.070E-06 | DCF2( 2)
B-1  | Co-60                                                      | 2.190E-04 | 2.190E-04 | DCF2( 3)
B-1  | Cs-137+D                                                   | 3.190E-05 | 3.190E-05 | DCF2( 4)
B-1  | H-3                                                        | 6.400E-08 | 6.400E-08 | DCF2( 5)
B-1  | Pa-231                                                     | 1.280E+00 | 1.280E+00 | DCF2( 6)
B-1  | Pb-210+D                                                   | 2.320E-02 | 2.320E-02 | DCF2( 7)
B-1  | Pu-239                                                     | 4.290E-01 | 4.290E-01 | DCF2( 8)
B-1  | Pu-240                                                     | 4.290E-01 | 4.290E-01 | DCF2( 9)
B-1  | Ra-226+D                                                   | 8.600E-03 | 8.600E-03 | DCF2(10)
B-1  | Ra-228+D                                                   | 5.080E-03 | 5.080E-03 | DCF2(11)
B-1  | Th-228+D                                                   | 3.450E-01 | 3.450E-01 | DCF2(12)
B-1  | Th-230                                                     | 3.260E-01 | 3.260E-01 | DCF2(13)
B-1  | Th-232                                                     | 1.640E+00 | 1.640E+00 | DCF2(14)
B-1  | U-234                                                      | 1.320E-01 | 1.320E-01 | DCF2(15)
B-1  | U-235+D                                                    | 1.230E-01 | 1.230E-01 | DCF2(16)
B-1  | U-236                                                      | 1.250E-01 | 1.250E-01 | DCF2(17)
B-1  | U-238+D                                                    | 1.180E-01 | 1.180E-01 | DCF2(18)
     |                                                            |           |           |
D-1  | Dose conversion factors for ingestion, mrem/pCi:           |           |           |
D-1  | Ac-227+D                                                   | 1.480E-02 | 1.480E-02 | DCF3( 1)
D-1  | Co-57                                                      | 1.180E-06 | 1.180E-06 | DCF3( 2)
D-1  | Co-60                                                      | 2.690E-05 | 2.690E-05 | DCF3( 3)
D-1  | Cs-137+D                                                   | 5.000E-05 | 5.000E-05 | DCF3( 4)
D-1  | H-3                                                        | 6.400E-08 | 6.400E-08 | DCF3( 5)
D-1  | Pa-231                                                     | 1.060E-02 | 1.060E-02 | DCF3( 6)
D-1  | Pb-210+D                                                   | 7.270E-03 | 7.270E-03 | DCF3( 7)
D-1  | Pu-239                                                     | 3.540E-03 | 3.540E-03 | DCF3( 8)
D-1  | Pu-240                                                     | 3.540E-03 | 3.540E-03 | DCF3( 9)
D-1  | Ra-226+D                                                   | 1.330E-03 | 1.330E-03 | DCF3(10)
D-1  | Ra-228+D                                                   | 1.440E-03 | 1.440E-03 | DCF3(11)
D-1  | Th-228+D                                                   | 8.080E-04 | 8.080E-04 | DCF3(12)
D-1  | Th-230                                                     | 5.480E-04 | 5.480E-04 | DCF3(13)
D-1  | Th-232                                                     | 2.730E-03 | 2.730E-03 | DCF3(14)
D-1  | U-234                                                      | 2.830E-04 | 2.830E-04 | DCF3(15)
D-1  | U-235+D                                                    | 2.670E-04 | 2.670E-04 | DCF3(16)
D-1  | U-236                                                      | 2.690E-04 | 2.690E-04 | DCF3(17)
D-1  | U-238+D                                                    | 2.690E-04 | 2.690E-04 | DCF3(18)
     |                                                            |           |           |
D-34 | Food transfer factors:                                     |           |           |
D-34 | Ac-227+D , plant/soil concentration ratio, dimensionless   | 2.500E-03 | 2.500E-03 | RTF( 1,1)
D-34 | Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 2.000E-05 | 2.000E-05 | RTF( 1,2)
D-34 | Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 2.000E-05 | 2.000E-05 | RTF( 1,3)
D-34 |                                                            |           |           |
D-34 | Co-57    , plant/soil concentration ratio, dimensionless   | 8.000E-02 | 8.000E-02 | RTF( 2,1)
D-34 | Co-57    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 2.000E-02 | 2.000E-02 | RTF( 2,2)
D-34 | Co-57    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 2.000E-03 | 2.000E-03 | RTF( 2,3)
D-34 |                                                            |           |           |
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                          Dose Conversion Factor (and Related) Parameter Summary (continued)
                                              File: DOSFAC.BIN

     |                                                           | Current   |           | Parameter
Menu |                         Parameter                         |  Value    |  Default  |   Name
-----+-----------------------------------------------------------+-----------+-----------+------------
D-34 | Co-60     , plant/soil concentration ratio, dimensionless | 8.000E-02 | 8.000E-02 | RTF( 3,1)
D-34 | Co-60     , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-02 | 2.000E-02 | RTF( 3,2)
D-34 | Co-60     , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 2.000E-03 | 2.000E-03 | RTF( 3,3)
D-34 |                                                           |           |           |
D-34 | Cs-137+D  , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 4,1)
D-34 | Cs-137+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 4,2)
D-34 | Cs-137+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 8.000E-03 | 8.000E-03 | RTF( 4,3)
D-34 |                                                           |           |           |
D-34 | H-3       , plant/soil concentration ratio, dimensionless | 4.800E+00 | 4.800E+00 | RTF( 5,1)
D-34 | H-3       , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.200E-02 | 1.200E-02 | RTF( 5,2)
D-34 | H-3       , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-02 | 1.000E-02 | RTF( 5,3)
D-34 |                                                           |           |           |
D-34 | Pa-231    , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 6,1)
D-34 | Pa-231    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 6,2)
D-34 | Pa-231    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF( 6,3)
D-34 |                                                           |           |           |
D-34 | Pb-210+D  , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 7,1)
D-34 | Pb-210+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04 | 8.000E-04 | RTF( 7,2)
D-34 | Pb-210+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 3.000E-04 | 3.000E-04 | RTF( 7,3)
D-34 |                                                           |           |           |
D-34 | Pu-239    , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 8,1)
D-34 | Pu-239    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 8,2)
D-34 | Pu-239    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-06 | 1.000E-06 | RTF( 8,3)
D-34 |                                                           |           |           |
D-34 | Pu-240    , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 9,1)
D-34 | Pu-240    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 9,2)
D-34 | Pu-240    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-06 | 1.000E-06 | RTF( 9,3)
D-34 |                                                           |           |           |
D-34 | Ra-226+D  , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF(10,1)
D-34 | Ra-226+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF(10,2)
D-34 | Ra-226+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03 | 1.000E-03 | RTF(10,3)
D-34 |                                                           |           |           |
D-34 | Ra-228+D  , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF(11,1)
D-34 | Ra-228+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF(11,2)
D-34 | Ra-228+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03 | 1.000E-03 | RTF(11,3)
D-34 |                                                           |           |           |
D-34 | Th-228+D  , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF(12,1)
D-34 | Th-228+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF(12,2)
D-34 | Th-228+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF(12,3)
D-34 |                                                           |           |           |
D-34 | Th-230    , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF(13,1)
D-34 | Th-230    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF(13,2)
D-34 | Th-230    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF(13,3)
D-34 |                                                           |           |           |
D-34 | Th-232    , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF(14,1)
D-34 | Th-232    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF(14,2)
D-34 | Th-232    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF(14,3)
D-34 |                                                           |           |           |
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                        Dose Conversion Factor (and Related) Parameter Summary (continued)
                                              File: DOSFAC.BIN

     |                                                            |  Current   |            | Parameter
Menu |                         Parameter                          |   Value    |  Default   |   Name
-----+------------------------------------------------------------+------------+------------+--------------
D-34 | U-234    , plant/soil concentration ratio, dimensionless   | 2.500E-03  | 2.500E-03  | RTF(15,1)
D-34 | U-234    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 3.400E-04  | 3.400E-04  | RTF(15,2)
D-34 | U-234    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 6.000E-04  | 6.000E-04  | RTF(15,3)
D-34 |                                                            |            |            |
D-34 | U-235+D  , plant/soil concentration ratio, dimensionless   | 2.500E-03  | 2.500E-03  | RTF(16,1)
D-34 | U-235+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 3.400E-04  | 3.400E-04  | RTF(16,2)
D-34 | U-235+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 6.000E-04  | 6.000E-04  | RTF(16,3)
D-34 |                                                            |            |            |
D-34 | U-236    , plant/soil concentration ratio, dimensionless   | 2.500E-03  | 2.500E-03  | RTF(17,1)
D-34 | U-236    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 3.400E-04  | 3.400E-04  | RTF(17,2)
D-34 | U-236    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 6.000E-04  | 6.000E-04  | RTF(17,3)
D-34 |                                                            |            |            |
D-34 | U-238+D  , plant/soil concentration ratio, dimensionless   | 2.500E-03  | 2.500E-03  | RTF(18,1)
D-34 | U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 3.400E-04  | 3.400E-04  | RTF(18,2)
D-34 | U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 6.000E-04  | 6.000E-04  | RTF(18,3)
     |                                                            |            |            |
D-5  | Bioaccumulation factors, fresh water, L/kg:                |            |            |
D-5  | Ac-227+D , fish                                            | 1.500E+01  | 1.500E+01  | BIOFAC( 1,1)
D-5  | Ac-227+D , crustacea and mollusks                          | 1.000E+03  | 1.000E+03  | BIOFAC( 1,2)
D-5  |                                                            |            |            |
D-5  | Co-57    , fish                                            | 3.000E+02  | 3.000E+02  | BIOFAC( 2,1)
D-5  | Co-57    , crustacea and mollusks                          | 2.000E+02  | 2.000E+02  | BIOFAC( 2,2)
D-5  |                                                            |            |            |
D-5  | Co-60    , fish                                            | 3.000E+02  | 3.000E+02  | BIOFAC( 3,1)
D-5  | Co-60    , crustacea and mollusks                          | 2.000E+02  | 2.000E+02  | BIOFAC( 3,2)
D-5  |                                                            |            |            |
D-5  | Cs-137+D , fish                                            | 2.000E+03  | 2.000E+03  | BIOFAC( 4,1)
D-5  | Cs-137+D , crustacea and mollusks                          | 1.000E+02  | 1.000E+02  | BIOFAC( 4,2)
D-5  |                                                            |            |            |
D-5  | H-3      , fish                                            | 1.000E+00  | 1.000E+00  | BIOFAC( 5,1)
D-5  | H-3      , crustacea and mollusks                          | 1.000E+00  | 1.000E+00  | BIOFAC( 5,2)
D-5  |                                                            |            |            |
D-5  | Pa-231   , fish                                            | 1.000E+01  | 1.000E+01  | BIOFAC( 6,1)
D-5  | Pa-231   , crustacea and mollusks                          | 1.100E+02  | 1.100E+02  | BIOFAC( 6,2)
D-5  |                                                            |            |            |
D-5  | Pb-210+D , fish                                            | 3.000E+02  | 3.000E+02  | BIOFAC( 7,1)
D-5  | Pb-210+D , crustacea and mollusks                          | 1.000E+02  | 1.000E+02  | BIOFAC( 7,2)
D-5  |                                                            |            |            |
D-5  | Pu-239   , fish                                            | 3.000E+01  | 3.000E+01  | BIOFAC( 8,1)
D-5  | Pu-239   , crustacea and mollusks                          | 1.000E+02  | 1.000E+02  | BIOFAC( 8,2)
D-5  |                                                            |            |            |
D-5  | Pu-240   , fish                                            | 3.000E+01  | 3.000E+01  | BIOFAC( 9,1)
D-5  | Pu-240   , crustacea and mollusks                          | 1.000E+02  | 1.000E+02  | BIOFAC( 9,2)
D-5  |                                                            |            |            |
D-5  | Ra-226+D , fish                                            | 5.000E+01  | 5.000E+01  | BIOFAC(10,1)
D-5  | Ra-226+D , crustacea and mollusks                          | 2.500E+02  | 2.500E+02  | BIOFAC(10,2)
D-5  |                                                            |            |            |
D-5  | Ra-228+D , fish                                            | 5.000E+01  | 5.000E+01  | BIOFAC(11,1)
D-5  | Ra-228+D , crustacea and mollusks                          | 2.500E+02  | 2.500E+02  | BIOFAC(11,2)
D-5  |                                                            |            |            |
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                 Dose Conversion Factor (and Related) Parameter Summary (continued)
                                          File: DOSFAC.BIN

     |                                                      | Current   |           | Parameter
Menu |                  Parameter                           |  Value    |  Default  |   Name
-----+------------------------------------------------------+-----------+-----------+--------------
D-5  | Th-228+D , fish                                      | 1.000E+02 | 1.000E+02 | BIOFAC(12,1)
D-5  | Th-228+D , crustacea and mollusks                    | 5.000E+02 | 5.000E+02 | BIOFAC(12,2)
D-5  |                                                      |           |           |
D-5  | Th-230   , fish                                      | 1.000E+02 | 1.000E+02 | BIOFAC(13,1)
D-5  | Th-230   , crustacea and mollusks                    | 5.000E+02 | 5.000E+02 | BIOFAC(13,2)
D-5  |                                                      |           |           |
D-5  | Th-232   , fish                                      | 1.000E+02 | 1.000E+02 | BIOFAC(14,1)
D-5  | Th-232   , crustacea and mollusks                    | 5.000E+02 | 5.000E+02 | BIOFAC(14,2)
D-5  |                                                      |           |           |
D-5  | U-234    , fish                                      | 1.000E+01 | 1.000E+01 | BIOFAC(15,1)
D-5  | U-234    , crustacea and mollusks                    | 6.000E+01 | 6.000E+01 | BIOFAC(15,2)
D-5  |                                                      |           |           |
D-5  | U-235+D  , fish                                      | 1.000E+01 | 1.000E+01 | BIOFAC(16,1)
D-5  | U-235+D  , crustacea and mollusks                    | 6.000E+01 | 6.000E+01 | BIOFAC(16,2)
D-5  |                                                      |           |           |
D-5  | U-236    , fish                                      | 1.000E+01 | 1.000E+01 | BIOFAC(17,1)
D-5  | U-236    , crustacea and mollusks                    | 6.000E+01 | 6.000E+01 | BIOFAC(17,2)
D-5  |                                                      |           |           |
D-5  | U-238+D  , fish                                      | 1.000E+01 | 1.000E+01 | BIOFAC(18,1)
D-5  | U-238+D  , crustacea and mollusks                    | 6.000E+01 | 6.000E+01 | BIOFAC(18,2)
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                                              Site-Specific Parameter Summary

     |                                                  |    User    |            |          Used by RESRAD          | Parameter
Menu |                    Parameter                     |   Input    |  Default   | (If different from user input)   |   Name
-----+--------------------------------------------------+------------+------------+----------------------------------+------------
R011 | Area of contaminated zone (m**2)                 | 3.439E+03  | 1.000E+04  |               ---                | AREA
R011 | Thickness of contaminated zone (m)               | 2.000E+00  | 2.000E+00  |               ---                | THICK0
R011 | Length parallel to aquifer flow (m)              | not used   | 1.000E+02  |               ---                | LCZPAQ
R011 | Basic radiation dose limit (mrem/yr)             | 1.000E+01  | 3.000E+01  |               ---                | BRDL
R011 | Time since placement of material (yr)            | 0.000E+00  | 0.000E+00  |               ---                | TI
R011 | Times for calculations (yr)                      | 1.000E+00  | 1.000E+00  |               ---                | T( 2)
R011 | Times for calculations (yr)                      | 5.000E+00  | 3.000E+00  |               ---                | T( 3)
R011 | Times for calculations (yr)                      | 1.000E+01  | 1.000E+01  |               ---                | T( 4)
R011 | Times for calculations (yr)                      | 2.500E+01  | 3.000E+01  |               ---                | T( 5)
R011 | Times for calculations (yr)                      | 4.000E+01  | 1.000E+02  |               ---                | T( 6)
R011 | Times for calculations (yr)                      | 5.500E+01  | 3.000E+02  |               ---                | T( 7)
R011 | Times for calculations (yr)                      | 7.000E+01  | 1.000E+03  |               ---                | T( 8)
R011 | Times for calculations (yr)                      | not used   | 0.000E+00  |               ---                | T( 9)
R011 | Times for calculations (yr)                      | not used   | 0.000E+00  |               ---                | T(10)
     |                                                  |            |            |                                  |
R012 | Initial principal radionuclide (pCi/g):  Ac-227  | 1.000E+00  | 0.000E+00  |               ---                | S1( 1)
R012 | Initial principal radionuclide (pCi/g):  Co-57   | 1.000E+00  | 0.000E+00  |               ---                | S1( 2)
R012 | Initial principal radionuclide (pCi/g):  Co-60   | 1.000E+00  | 0.000E+00  |               ---                | S1( 3)
R012 | Initial principal radionuclide (pCi/g):  Cs-137  | 1.000E+00  | 0.000E+00  |               ---                | S1( 4)
R012 | Initial principal radionuclide (pCi/g):  H-3     | 1.000E+00  | 0.000E+00  |               ---                | S1( 5)
R012 | Initial principal radionuclide (pCi/g):  Pb-210  | 1.000E+00  | 0.000E+00  |               ---                | S1( 7)
R012 | Initial principal radionuclide (pCi/g):  Pu-239  | 1.000E+00  | 0.000E+00  |               ---                | S1( 8)
R012 | Initial principal radionuclide (pCi/g):  Pu-240  | 1.000E+00  | 0.000E+00  |               ---                | S1( 9)
R012 | Initial principal radionuclide (pCi/g):  Ra-226  | 1.000E+00  | 0.000E+00  |               ---                | S1(10)
R012 | Initial principal radionuclide (pCi/g):  Ra-228  | 1.000E+00  | 0.000E+00  |               ---                | S1(11)
R012 | Initial principal radionuclide (pCi/g):  Th-228  | 1.000E+00  | 0.000E+00  |               ---                | S1(12)
R012 | Initial principal radionuclide (pCi/g):  Th-230  | 1.000E+00  | 0.000E+00  |               ---                | S1(13)
R012 | Initial principal radionuclide (pCi/g):  Th-232  | 1.000E+00  | 0.000E+00  |               ---                | S1(14)
R012 | Initial principal radionuclide (pCi/g):  U-234   | 1.000E+00  | 0.000E+00  |               ---                | S1(15)
R012 | Initial principal radionuclide (pCi/g):  U-235   | 1.000E+00  | 0.000E+00  |               ---                | S1(16)
R012 | Initial principal radionuclide (pCi/g):  U-238   | 1.000E+00  | 0.000E+00  |               ---                | S1(18)
R012 | Concentration in groundwater   (pCi/L):  Ac-227  | not used   | 0.000E+00  |               ---                | W1( 1)
R012 | Concentration in groundwater   (pCi/L):  Co-57   | not used   | 0.000E+00  |               ---                | W1( 2)
R012 | Concentration in groundwater   (pCi/L):  Co-60   | not used   | 0.000E+00  |               ---                | W1( 3)
R012 | Concentration in groundwater   (pCi/L):  Cs-137  | not used   | 0.000E+00  |               ---                | W1( 4)
R012 | Concentration in groundwater   (pCi/L):  H-3     | not used   | 0.000E+00  |               ---                | W1( 5)
R012 | Concentration in groundwater   (pCi/L):  Pb-210  | not used   | 0.000E+00  |               ---                | W1( 7)
R012 | Concentration in groundwater   (pCi/L):  Pu-239  | not used   | 0.000E+00  |               ---                | W1( 8)
R012 | Concentration in groundwater   (pCi/L):  Pu-240  | not used   | 0.000E+00  |               ---                | W1( 9)
R012 | Concentration in groundwater   (pCi/L):  Ra-226  | not used   | 0.000E+00  |               ---                | W1(10)
R012 | Concentration in groundwater   (pCi/L):  Ra-228  | not used   | 0.000E+00  |               ---                | W1(11)
R012 | Concentration in groundwater   (pCi/L):  Th-228  | not used   | 0.000E+00  |               ---                | W1(12)
R012 | Concentration in groundwater   (pCi/L):  Th-230  | not used   | 0.000E+00  |               ---                | W1(13)
R012 | Concentration in groundwater   (pCi/L):  Th-232  | not used   | 0.000E+00  |               ---                | W1(14)
R012 | Concentration in groundwater   (pCi/L):  U-234   | not used   | 0.000E+00  |               ---                | W1(15)
R012 | Concentration in groundwater   (pCi/L):  U-235   | not used   | 0.000E+00  |               ---                | W1(16)
R012 | Concentration in groundwater   (pCi/L):  U-238   | not used   | 0.000E+00  |               ---                | W1(18)
     |                                                  |            |            |                                  |
R013 | Cover depth (m)                                  | 0.000E+00  | 0.000E+00  |               ---                | COVER0
R013 | Density of cover material (g/cm**3)              | not used   | 1.500E+00  |               ---                | DENSCV
```

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                          Site-Specific Parameter Summary (continued)

     |                                                |   User    |           |     Used by RESRAD               |   Parameter
Menu |                Parameter                       |   Input   |  Default  | (If different from user input)   |     Name
-----|------------------------------------------------|-----------|-----------|----------------------------------|-------------
R013 | Cover depth erosion rate (m/yr)                | not used  | 1.000E-03 |               ---                | VCV
R013 | Density of contaminated zone (g/cm**3)         | 1.500E+00 | 1.500E+00 |               ---                | DENSCZ
R013 | Contaminated zone erosion rate (m/yr)          | 6.000E-05 | 1.000E-03 |               ---                | VCZ
R013 | Contaminated zone total porosity               | 3.700E-01 | 4.000E-01 |               ---                | TPCZ
R013 | Contaminated zone effective porosity           | 1.750E-01 | 2.000E-01 |               ---                | EPCZ
R013 | Contaminated zone hydraulic conductivity (m/yr)| 2.080E+02 | 1.000E+01 |               ---                | HCCZ
R013 | Contaminated zone b parameter                  | 7.750E+00 | 5.300E+00 |               ---                | BCZ
R013 | Average annual wind speed (m/sec)              | 3.000E+00 | 2.000E+00 |               ---                | WIND
R013 | Humidity in air (g/m**3)                       | 6.600E+00 | 8.000E+00 |               ---                | HUMID
R013 | Evapotranspiration coefficient                 | 7.100E-01 | 5.000E-01 |               ---                | EVAPTR
R013 | Precipitation (m/yr)                           | 7.500E-01 | 1.000E+00 |               ---                | PRECIP
R013 | Irrigation (m/yr)                              | 0.000E+00 | 2.000E-01 |               ---                | RI
R013 | Irrigation mode                                | overhead  | overhead  |               ---                | IDITCH
R013 | Runoff coefficient                             | 2.000E-01 | 2.000E-01 |               ---                | RUNOFF
R013 | Watershed area for nearby stream or pond (m**2)| not used  | 1.000E+06 |               ---                | WAREA
R013 | Accuracy for water/soil computations           | not used  | 1.000E-03 |               ---                | EPS
     |                                                |           |           |                                  |
R014 | Density of saturated zone (g/cm**3)            | 1.500E+00 | 1.500E+00 |               ---                | DENSAQ
R014 | Saturated zone total porosity                  | 3.700E-01 | 4.000E-01 |               ---                | TPSZ
R014 | Saturated zone effective porosity              | 1.750E-01 | 2.000E-01 |               ---                | EPSZ
R014 | Saturated zone hydraulic conductivity (m/yr)   | 2.080E+02 | 1.000E+02 |               ---                | HCSZ
R014 | Saturated zone hydraulic gradient              | 1.200E-02 | 2.000E-02 |               ---                | HGWT
R014 | Saturated zone b parameter                     | 1.040E+01 | 5.300E+00 |               ---                | BSZ
R014 | Water table drop rate (m/yr)                   | 0.000E+00 | 1.000E-03 |               ---                | VWT
R014 | Well pump intake depth (m below water table)   | 3.000E+00 | 1.000E+01 |               ---                | DWIBWT
R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | ND        | ND        |               ---                | MODEL
R014 | Well pumping rate (m**3/yr)                    | 5.000E+01 | 2.500E+02 |               ---                | UW
     |                                                |           |           |                                  |
R015 | Number of unsaturated zone strata              | not used  | 1         |               ---                | NS
R015 | Unsat. zone 1, thickness (m)                   | not used  | 4.000E+00 |               ---                | H(1)
R015 | Unsat. zone 1, soil density (g/cm**3)          | not used  | 1.500E+00 |               ---                | DENSUZ(1)
R015 | Unsat. zone 1, total porosity                  | not used  | 4.000E-01 |               ---                | TPUZ(1)
R015 | Unsat. zone 1, effective porosity              | not used  | 2.000E-01 |               ---                | EPUZ(1)
R015 | Unsat. zone 1, soil-specific b parameter       | not used  | 5.300E+00 |               ---                | BUZ(1)
R015 | Unsat. zone 1, hydraulic conductivity (m/yr)   | not used  | 1.000E+01 |               ---                | HCUZ(1)
     |                                                |           |           |                                  |
R016 | Distribution coefficients for Ac-227           |           |           |                                  |
R016 |   Contaminated zone (cm**3/g)                  | 2.000E+01 | 2.000E+01 |               ---                | DCNUCC( 1)
R016 |   Unsaturated zone 1 (cm**3/g)                 | not used  | 2.000E+01 |               ---                | DCNUCU( 1,1)
R016 |   Saturated zone (cm**3/g)                     | not used  | 2.000E+01 |               ---                | DCNUCS( 1)
R016 |   Leach rate (/yr)                             | 0.000E+00 | 0.000E+00 |            2.876E-03             | ALEACH( 1)
R016 |   Solubility constant                          | 0.000E+00 | 0.000E+00 |            not used              | SOLUBK( 1)
     |                                                |           |           |                                  |
R016 | Distribution coefficients for Co-57            |           |           |                                  |
R016 |   Contaminated zone (cm**3/g)                  | 1.000E+03 | 1.000E+03 |               ---                | DCNUCC( 2)
R016 |   Unsaturated zone 1 (cm**3/g)                 | not used  | 1.000E+03 |               ---                | DCNUCU( 2,1)
R016 |   Saturated zone (cm**3/g)                     | not used  | 1.000E+03 |               ---                | DCNUCS( 2)
R016 |   Leach rate (/yr)                             | 0.000E+00 | 0.000E+00 |            5.799E-05             | ALEACH( 2)
R016 |   Solubility constant                          | 0.000E+00 | 0.000E+00 |            not used              | SOLUBK( 2)
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                                   Site-Specific Parameter Summary (continued)

     |                                                  |    User    |            |     Used by RESRAD                 |  Parameter
Menu |                   Parameter                      |    Input   |  Default   | (If different from user input)     |    Name
-----+--------------------------------------------------+------------+------------+------------------------------------+--------------
R016 | Distribution coefficients for Co-60              |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 1.000E+03  | 1.000E+03  |              ---                   | DCNUCC( 3)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 1.000E+03  |              ---                   | DCNUCU( 3,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 1.000E+03  |              ---                   | DCNUCS( 3)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           5.799E-05                | ALEACH( 3)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 3)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Cs-137             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 1.000E+03  | 1.000E+03  |              ---                   | DCNUCC( 4)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 1.000E+03  |              ---                   | DCNUCU( 4,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 1.000E+03  |              ---                   | DCNUCS( 4)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           5.799E-05                | ALEACH( 4)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 4)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for H-3                |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 0.000E+00  | 0.000E+00  |              ---                   | DCNUCC( 5)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 0.000E+00  |              ---                   | DCNUCU( 5,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 0.000E+00  |              ---                   | DCNUCS( 5)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           3.449E-01                | ALEACH( 5)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 5)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Pb-210             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 1.000E+02  | 1.000E+02  |              ---                   | DCNUCC( 7)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 1.000E+02  |              ---                   | DCNUCU( 7,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 1.000E+02  |              ---                   | DCNUCS( 7)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           5.790E-04                | ALEACH( 7)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 7)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Pu-239             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 2.000E+03  | 2.000E+03  |              ---                   | DCNUCC( 8)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 2.000E+03  |              ---                   | DCNUCU( 8,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 2.000E+03  |              ---                   | DCNUCS( 8)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           2.900E-05                | ALEACH( 8)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 8)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Pu-240             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 2.000E+03  | 2.000E+03  |              ---                   | DCNUCC( 9)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 2.000E+03  |              ---                   | DCNUCU( 9,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 2.000E+03  |              ---                   | DCNUCS( 9)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           2.900E-05                | ALEACH( 9)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 9)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Ra-226             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 7.000E+01  | 7.000E+01  |              ---                   | DCNUCC(10)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 7.000E+01  |              ---                   | DCNUCU(10,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 7.000E+01  |              ---                   | DCNUCS(10)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           8.266E-04                | ALEACH(10)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK(10)
```

```
                              Site-Specific Parameter Summary (continued)

     |                                                       |   User    |            |      Used by RESRAD                  | Parameter
Menu |                 Parameter                             |   Input   |  Default   | (If different from user input)       |   Name
-----+-------------------------------------------------------+-----------+------------+--------------------------------------+------------
R016 | Distribution coefficients for Ra-228                  |           |            |                                      |
R016 |   Contaminated zone (cm**3/g)                         | 7.000E+01 | 7.000E+01  |               ---                    | DCNUCC(11)
R016 |   Unsaturated zone 1 (cm**3/g)                        | not used  | 7.000E+01  |               ---                    | DCNUCU(11,1)
R016 |   Saturated zone (cm**3/g)                            | not used  | 7.000E+01  |               ---                    | DCNUCS(11)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00  |           8.266E-04                  | ALEACH(11)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00  |           not used                   | SOLUBK(11)
     |                                                       |           |            |                                      |
R016 | Distribution coefficients for Th-228                  |           |            |                                      |
R016 |   Contaminated zone (cm**3/g)                         | 6.000E+04 | 6.000E+04  |               ---                    | DCNUCC(12)
R016 |   Unsaturated zone 1 (cm**3/g)                        | not used  | 6.000E+04  |               ---                    | DCNUCU(12,1)
R016 |   Saturated zone (cm**3/g)                            | not used  | 6.000E+04  |               ---                    | DCNUCS(12)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00  |           9.667E-07                  | ALEACH(12)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00  |           not used                   | SOLUBK(12)
     |                                                       |           |            |                                      |
R016 | Distribution coefficients for Th-230                  |           |            |                                      |
R016 |   Contaminated zone (cm**3/g)                         | 6.000E+04 | 6.000E+04  |               ---                    | DCNUCC(13)
R016 |   Unsaturated zone 1 (cm**3/g)                        | not used  | 6.000E+04  |               ---                    | DCNUCU(13,1)
R016 |   Saturated zone (cm**3/g)                            | not used  | 6.000E+04  |               ---                    | DCNUCS(13)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00  |           9.667E-07                  | ALEACH(13)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00  |           not used                   | SOLUBK(13)
     |                                                       |           |            |                                      |
R016 | Distribution coefficients for Th-232                  |           |            |                                      |
R016 |   Contaminated zone (cm**3/g)                         | 6.000E+04 | 6.000E+04  |               ---                    | DCNUCC(14)
R016 |   Unsaturated zone 1 (cm**3/g)                        | not used  | 6.000E+04  |               ---                    | DCNUCU(14,1)
R016 |   Saturated zone (cm**3/g)                            | not used  | 6.000E+04  |               ---                    | DCNUCS(14)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00  |           9.667E-07                  | ALEACH(14)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00  |           not used                   | SOLUBK(14)
     |                                                       |           |            |                                      |
R016 | Distribution coefficients for U-234                   |           |            |                                      |
R016 |   Contaminated zone (cm**3/g)                         | 5.000E+01 | 5.000E+01  |               ---                    | DCNUCC(15)
R016 |   Unsaturated zone 1 (cm**3/g)                        | not used  | 5.000E+01  |               ---                    | DCNUCU(15,1)
R016 |   Saturated zone (cm**3/g)                            | not used  | 5.000E+01  |               ---                    | DCNUCS(15)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00  |           1.156E-03                  | ALEACH(15)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00  |           not used                   | SOLUBK(15)
     |                                                       |           |            |                                      |
R016 | Distribution coefficients for U-235                   |           |            |                                      |
R016 |   Contaminated zone (cm**3/g)                         | 5.000E+01 | 5.000E+01  |               ---                    | DCNUCC(16)
R016 |   Unsaturated zone 1 (cm**3/g)                        | not used  | 5.000E+01  |               ---                    | DCNUCU(16,1)
R016 |   Saturated zone (cm**3/g)                            | not used  | 5.000E+01  |               ---                    | DCNUCS(16)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00  |           1.156E-03                  | ALEACH(16)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00  |           not used                   | SOLUBK(16)
     |                                                       |           |            |                                      |
R016 | Distribution coefficients for U-238                   |           |            |                                      |
R016 |   Contaminated zone (cm**3/g)                         | 5.000E+01 | 5.000E+01  |               ---                    | DCNUCC(18)
R016 |   Unsaturated zone 1 (cm**3/g)                        | not used  | 5.000E+01  |               ---                    | DCNUCU(18,1)
R016 |   Saturated zone (cm**3/g)                            | not used  | 5.000E+01  |               ---                    | DCNUCS(18)
R016 |   Leach rate (/yr)                                    | 0.000E+00 | 0.000E+00  |           1.156E-03                  | ALEACH(18)
R016 |   Solubility constant                                 | 0.000E+00 | 0.000E+00  |           not used                   | SOLUBK(18)
```

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                              Site-Specific Parameter Summary (continued)

     |                                                  |    User    |            |           Used by RESRAD           |  Parameter
Menu |                    Parameter                     |    Input   |  Default   |  (If different from user input)    |    Name
-----+--------------------------------------------------+------------+------------+------------------------------------+--------------
R016 | Distribution coefficients for daughter Pa-231    |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 5.000E+01  | 5.000E+01  |                ---                 | DCNUCC( 6)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 5.000E+01  |                ---                 | DCNUCU( 6,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 5.000E+01  |                ---                 | DCNUCS( 6)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |             1.156E-03              | ALEACH( 6)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |             not used               | SOLUBK( 6)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for daughter U-236     |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    | 5.000E+01  | 5.000E+01  |                ---                 | DCNUCC(17)
R016 |   Unsaturated zone 1 (cm**3/g)                   | not used   | 5.000E+01  |                ---                 | DCNUCU(17,1)
R016 |   Saturated zone (cm**3/g)                       | not used   | 5.000E+01  |                ---                 | DCNUCS(17)
R016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |             1.156E-03              | ALEACH(17)
R016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |             not used               | SOLUBK(17)
     |                                                  |            |            |                                    |
R017 | Inhalation rate (m**3/yr)                        | 5.000E+03  | 8.400E+03  |                ---                 | INHALR
R017 | Mass loading for inhalation (g/m**3)             | 6.000E-04  | 1.000E-04  |                ---                 | MLINH
R017 | Exposure duration                                | 1.000E+00  | 3.000E+01  |                ---                 | ED
R017 | Shielding factor, inhalation                     | 4.000E-01  | 4.000E-01  |                ---                 | SHF3
R017 | Shielding factor, external gamma                 | 7.000E-01  | 7.000E-01  |                ---                 | SHF1
R017 | Fraction of time spent indoors                   | 1.000E-01  | 5.000E-01  |                ---                 | FIND
R017 | Fraction of time spent outdoors (on site)        | 4.000E-01  | 2.500E-01  |                ---                 | FOTD
R017 | Shape factor flag, external gamma                | 1.000E+00  | 1.000E+00  |   >0 shows circular AREA.          | FS
R017 | Radii of shape factor array (used if FS = -1):   |            |            |                                    |
R017 |   Outer annular radius (m), ring  1:             | not used   | 5.000E+01  |                ---                 | RAD SHAPE( 1)
R017 |   Outer annular radius (m), ring  2:             | not used   | 7.071E+01  |                ---                 | RAD SHAPE( 2)
R017 |   Outer annular radius (m), ring  3:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE( 3)
R017 |   Outer annular radius (m), ring  4:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE( 4)
R017 |   Outer annular radius (m), ring  5:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE( 5)
R017 |   Outer annular radius (m), ring  6:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE( 6)
R017 |   Outer annular radius (m), ring  7:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE( 7)
R017 |   Outer annular radius (m), ring  8:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE( 8)
R017 |   Outer annular radius (m), ring  9:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE( 9)
R017 |   Outer annular radius (m), ring 10:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE(10)
R017 |   Outer annular radius (m), ring 11:             | not used   | 0.000E+00  |                ---                 | RAD SHAPE(11)
R017 |   Outer annular radius (m), ring 12:             | not used   | 0.000E+00  |                ---                 | RAD_SHAPE(12)
     |                                                  |            |            |                                    |
R017 | Fractions of annular areas within AREA:          |            |            |                                    |
R017 |   Ring  1                                        | not used   | 1.000E+00  |                ---                 | FRACA( 1)
R017 |   Ring  2                                        | not used   | 2.732E-01  |                ---                 | FRACA( 2)
R017 |   Ring  3                                        | not used   | 0.000E+00  |                ---                 | FRACA( 3)
R017 |   Ring  4                                        | not used   | 0.000E+00  |                ---                 | FRACA( 4)
R017 |   Ring  5                                        | not used   | 0.000E+00  |                ---                 | FRACA( 5)
R017 |   Ring  6                                        | not used   | 0.000E+00  |                ---                 | FRACA( 6)
R017 |   Ring  7                                        | not used   | 0.000E+00  |                ---                 | FRACA( 7)
R017 |   Ring  8                                        | not used   | 0.000E+00  |                ---                 | FRACA( 8)
R017 |   Ring  9                                        | not used   | 0.000E+00  |                ---                 | FRACA( 9)
R017 |   Ring 10                                        | not used   | 0.000E+00  |                ---                 | FRACA(10)
R017 |   Ring 11                                        | not used   | 0.000E+00  |                ---                 | FRACA(11)
R017 |   Ring 12                                        | not used   | 0.000E+00  |                ---                 | FRACA(12)
```

```
                                   Site-Specific Parameter Summary (continued)

     |                                                     | User      |            |       Used by RESRAD           | Parameter
Menu |                    Parameter                        | Input     |  Default   | (If different from user input) |   Name
-----+-----------------------------------------------------+-----------+------------+--------------------------------+-----------
R018 | Fruits, vegetables and grain consumption (kg/yr)    | not used  | 1.600E+02  |              ---               | DIET(1)
R018 | Leafy vegetable consumption (kg/yr)                 | not used  | 1.400E+01  |              ---               | DIET(2)
R018 | Milk consumption (L/yr)                             | not used  | 9.200E+01  |              ---               | DIET(3)
R018 | Meat and poultry consumption (kg/yr)                | not used  | 6.300E+01  |              ---               | DIET(4)
R018 | Fish consumption (kg/yr)                            | not used  | 5.400E+00  |              ---               | DIET(5)
R018 | Other seafood consumption (kg/yr)                   | not used  | 9.000E-01  |              ---               | DIET(6)
R018 | Soil ingestion rate (g/yr)                          | 1.200E+02 | 3.650E+01  |              ---               | SOIL
R018 | Drinking water intake (L/yr)                        | not used  | 5.100E+02  |              ---               | DWI
R018 | Contamination fraction of drinking water            | not used  | 1.000E+00  |              ---               | FDW
R018 | Contamination fraction of household water           | not used  | 1.000E+00  |              ---               | FHHW
R018 | Contamination fraction of livestock water           | not used  | 1.000E+00  |              ---               | FLW
R018 | Contamination fraction of irrigation water          | not used  | 1.000E+00  |              ---               | FIRW
R018 | Contamination fraction of aquatic food              | not used  | 5.000E-01  |              ---               | FR9
R018 | Contamination fraction of plant food                | not used  |-1          |              ---               | FPLANT
R018 | Contamination fraction of meat                      | not used  |-1          |              ---               | FMEAT
R018 | Contamination fraction of milk                      | not used  |-1          |              ---               | FMILK
     |                                                     |           |            |                                |
R019 | Livestock fodder intake for meat (kg/day)           | not used  | 6.800E+01  |              ---               | LFI5
R019 | Livestock fodder intake for milk (kg/day)           | not used  | 5.500E+01  |              ---               | LFI6
R019 | Livestock water intake for meat (L/day)             | not used  | 5.000E+01  |              ---               | LWI5
R019 | Livestock water intake for milk (L/day)             | not used  | 1.600E+02  |              ---               | LWI6
R019 | Livestock soil intake (kg/day)                      | not used  | 5.000E-01  |              ---               | LSI
R019 | Mass loading for foliar deposition (g/m**3)         | not used  | 1.000E-04  |              ---               | MLFD
R019 | Depth of soil mixing layer (m)                      | 1.500E-01 | 1.500E-01  |              ---               | DM
R019 | Depth of roots (m)                                  | not used  | 9.000E-01  |              ---               | DROOT
R019 | Drinking water fraction from ground water           | 1.000E+00 | 1.000E+00  |              ---               | FGWDW
R019 | Household water fraction from ground water          | not used  | 1.000E+00  |              ---               | FGWHH
R019 | Livestock water fraction from ground water          | not used  | 1.000E+00  |              ---               | FGWLW
R019 | Irrigation fraction from ground water               | not used  | 1.000E+00  |              ---               | FGWIR
     |                                                     |           |            |                                |
R19B | Wet weight crop yield for Non-Leafy (kg/m**2)       | not used  | 7.000E-01  |              ---               | YV(1)
R19B | Wet weight crop yield for Leafy     (kg/m**2)       | not used  | 1.500E+00  |              ---               | YV(2)
R19B | Wet weight crop yield for Fodder    (kg/m**2)       | not used  | 1.100E+00  |              ---               | YV(3)
R19B | Growing Season for  Non-Leafy (years)               | not used  | 1.700E-01  |              ---               | TE(1)
R19B | Growing Season for  Leafy     (years)               | not used  | 2.500E-01  |              ---               | TE(2)
R19B | Growing Season for  Fodder    (years)               | not used  | 8.000E-02  |              ---               | TE(3)
R19B | Translocation Factor for  Non-Leafy                 | not used  | 1.000E-01  |              ---               | TIV(1)
R19B | Translocation Factor for  Leafy                     | not used  | 1.000E+00  |              ---               | TIV(2)
R19B | Translocation Factor for  Fodder                    | not used  | 1.000E+00  |              ---               | TIV(3)
R19B | Dry Foliar Interception Fraction for  Non-Leafy     | not used  | 2.500E-01  |              ---               | RDRY(1)
R19B | Dry Foliar Interception Fraction for  Leafy         | not used  | 2.500E-01  |              ---               | RDRY(2)
R19B | Dry Foliar Interception Fraction for  Fodder        | not used  | 2.500E-01  |              ---               | RDRY(3)
R19B | Wet Foliar Interception Fraction for  Non-Leafy     | not used  | 2.500E-01  |              ---               | RWET(1)
R19B | Wet Foliar Interception Fraction for  Leafy         | not used  | 2.500E-01  |              ---               | RWET(2)
R19B | Wet Foliar Interception Fraction for  Fodder        | not used  | 2.500E-01  |              ---               | RWET(3)
R19B | Weathering Removal Constant for Vegetation          | not used  | 2.000E+01  |              ---               | WLAM
     |                                                     |           |            |                                |
C14  | C-12 concentration in water (g/cm**3)               | not used  | 2.000E-05  |              ---               | C12WTR
C14  | C-12 concentration in contaminated soil (g/g)       | not used  | 3.000E-02  |              ---               | C12CZ
C14  | Fraction of vegetation carbon from soil             | not used  | 2.000E-02  |              ---               | CSOIL
```

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

```
            Summary of Pathway Selections

            Pathway             |  User Selection
--------------------------------|----------------
   1 -- external gamma          |      active
   2 -- inhalation (w/o radon)  |      active
   3 -- plant ingestion         |    suppressed
   4 -- meat ingestion          |    suppressed
   5 -- milk ingestion          |    suppressed
   6 -- aquatic foods           |    suppressed
   7 -- drinking water          |    suppressed
   8 -- soil ingestion          |      active
   9 -- radon                   |    suppressed
   Find peak pathway doses      |    suppressed
================================|================
```

```
     Contaminated Zone Dimensions          Initial Soil Concentrations, pCi/g
     ____________________________          __________________________________

       Area:   3439.00 square meters                 Ac-227      1.000E+00
  Thickness:      2.00 meters                        Co-57       1.000E+00
Cover Depth:      0.00 meters                        Co-60       1.000E+00
                                                     Cs-137      1.000E+00
                                                     H-3         1.000E+00
                                                     Pb-210      1.000E+00
                                                     Pu-239      1.000E+00
                                                     Pu-240      1.000E+00
                                                     Ra-226      1.000E+00
                                                     Ra-228      1.000E+00
                                                     Th-228      1.000E+00
                                                     Th-230      1.000E+00
                                                     Th-232      1.000E+00
                                                     U-234       1.000E+00
                                                     U-235       1.000E+00
                                                     U-238       1.000E+00

                                        Total Dose TDOSE(t), mrem/yr
                                  Basic Radiation Dose Limit =  10 mrem/yr
                  Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                  _________________________________________________________________________

   t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
    TDOSE(t):  2.577E+01  2.463E+01  2.152E+01  1.920E+01  1.631E+01  1.527E+01  1.471E+01  1.434E+01
        M(t):  2.577E+00  2.463E+00  2.152E+00  1.920E+00  1.631E+00  1.527E+00  1.471E+00  1.434E+00

Maximum TDOSE(t):  2.577E+01 mrem/yr   at t = 0.000E+00 years
```

```
                           Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                         As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                          Water Independent Pathways (Inhalation excludes radon)

              Ground             Inhalation             Radon                Plant                Meat                 Milk                 Soil
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------
Ac-227  8.734E-01 0.0339  1.170E+00 0.0454  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.880E-01 0.0345
Co-57   2.206E-01 0.0086  1.579E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.080E-05 0.0000
Co-60   6.983E+00 0.2710  3.812E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.614E-03 0.0001
Cs-137  1.459E+00 0.0566  5.552E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.000E-03 0.0001
H-3     0.000E+00 0.0000  1.884E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.840E-06 0.0000
Pb-210  2.740E-03 0.0001  4.038E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.362E-01 0.0169
Pu-239  1.307E-04 0.0000  7.467E-02 0.0029  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.124E-01 0.0082
Pu-240  6.764E-05 0.0000  7.467E-02 0.0029  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.124E-01 0.0082
Ra-226  4.837E+00 0.1877  1.497E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.980E-02 0.0031
Ra-228  2.580E+00 0.1001  8.842E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.640E-02 0.0034
Th-228  4.415E+00 0.1713  6.005E-02 0.0023  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.848E-02 0.0019
Th-230  5.345E-04 0.0000  5.674E-02 0.0022  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.288E-02 0.0013
Th-232  2.311E-04 0.0000  2.855E-01 0.0111  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.638E-01 0.0064
U-234   1.792E-04 0.0000  2.298E-02 0.0009  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.698E-02 0.0007
U-235   3.317E-01 0.0129  2.141E-02 0.0008  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.602E-02 0.0006
U-238   5.926E-02 0.0023  2.054E-02 0.0008  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.614E-02 0.0006
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   2.176E+01 0.8445  1.793E+00 0.0696  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.214E+00 0.0859
```

```
                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                   Water Dependent Pathways

              Water               Fish               Radon              Plant               Meat               Milk           All Pathways*
Radio-  ------------------ ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
------- --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Ac-227  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.931E+00 0.1137
Co-57   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.207E-01 0.0086
Co-60   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.985E+00 0.2710
Cs-137  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.462E+00 0.0567
H-3     0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.922E-04 0.0000
Pb-210  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.430E-01 0.0172
Pu-239  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.872E-01 0.0111
Pu-240  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.871E-01 0.0111
Ra-226  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.918E+00 0.1908
Ra-228  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.667E+00 0.1035
Th-228  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.524E+00 0.1755
Th-230  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.016E-02 0.0035
Th-232  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.495E-01 0.0174
U-234   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.013E-02 0.0016
U-235   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.691E-01 0.0143
U-238   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.593E-02 0.0037
======= ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.577E+01 1.0000

*Sum of all water independent and dependent pathways.
```

```
                             Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                  Water Independent Pathways (Inhalation excludes radon)

              Ground             Inhalation              Radon                Plant                 Meat                 Milk                 Soil
Radio-   ----------------     ----------------     ----------------     ----------------     ----------------     ----------------     ----------------
Nuclide  mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
-------  --------- ------     --------- ------     --------- ------     --------- ------     --------- ------     --------- ------     --------- ------
Ac-227   8.436E-01 0.0342     1.130E+00 0.0459     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     8.577E-01 0.0348
Co-57    8.664E-02 0.0035     6.200E-07 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.781E-05 0.0000
Co-60    6.122E+00 0.2485     3.342E-05 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.415E-03 0.0001
Cs-137   1.426E+00 0.0579     5.425E-06 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.931E-03 0.0001
H-3      0.000E+00 0.0000     5.414E-05 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.104E-06 0.0000
Pb-210   2.654E-03 0.0001     3.912E-03 0.0002     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     4.226E-01 0.0172
Pu-239   1.307E-04 0.0000     7.467E-02 0.0030     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.124E-01 0.0086
Pu-240   6.763E-05 0.0000     7.466E-02 0.0030     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.124E-01 0.0086
Ra-226   4.831E+00 0.1961     1.618E-03 0.0001     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     9.304E-02 0.0038
Ra-228   3.544E+00 0.1439     1.791E-02 0.0007     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     9.035E-02 0.0037
Th-228   3.073E+00 0.1248     4.180E-02 0.0017     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.375E-02 0.0014
Th-230   2.628E-03 0.0001     5.674E-02 0.0023     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.292E-02 0.0013
Th-232   3.754E-01 0.0152     2.867E-01 0.0116     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.745E-01 0.0071
U-234    1.790E-04 0.0000     2.295E-02 0.0009     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.696E-02 0.0007
U-235    3.313E-01 0.0135     2.139E-02 0.0009     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.602E-02 0.0007
U-238    5.919E-02 0.0024     2.052E-02 0.0008     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.612E-02 0.0007
=======  ========= ======     ========= ======     ========= ======     ========= ======     ========= ======     ========= ======     ========= ======
Total    2.070E+01 0.8402     1.753E+00 0.0712     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.183E+00 0.0886
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RESRAD, Version 5.82     T½ Limit = 0.5 year       10/15/99  11:40     Page  18
Summary : SEAD-63 Construction Worker - Site Specific Parameters
File    : CONSTMAX.RAD

                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                          Water Dependent Pathways

             Water               Fish                Radon               Plant               Meat                Milk            All Pathways*
Radio-  ------------------- ------------------- ------------------- ------------------- ------------------- ------------------- -------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- -------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.831E+00 0.1149
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.667E-02 0.0035
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.124E+00 0.2486
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.429E+00 0.0580
H-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.524E-05 0.0000
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.292E-01 0.0174
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.872E-01 0.0117
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.871E-01 0.0117
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.925E+00 0.1999
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.652E+00 0.1483
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.149E+00 0.1278
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.229E-02 0.0037
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.366E-01 0.0340
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.009E-02 0.0016
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.687E-01 0.0150
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.582E-02 0.0039
======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= =======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.463E+01 1.0000

*Sum of all water independent and dependent pathways.
```

```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                   As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                        Water Independent Pathways (Inhalation excludes radon)

            Ground           Inhalation          Radon              Plant              Meat               Milk               Soil
Radio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
-------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Ac-227  7.343E-01 0.0341  9.833E-01 0.0457  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.465E-01 0.0347
Co-57   2.061E-03 0.0001  1.475E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.616E-07 0.0000
Co-60   3.617E+00 0.1681  1.975E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.360E-04 0.0000
Cs-137  1.300E+00 0.0604  4.945E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.672E-03 0.0001
H-3     0.000E+00 0.0000  3.692E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.527E-09 0.0000
Pb-210  2.339E-03 0.0001  3.447E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.723E-01 0.0173
Pu-239  1.307E-04 0.0000  7.465E-02 0.0035  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.123E-01 0.0099
Pu-240  6.759E-05 0.0000  7.462E-02 0.0035  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.123E-01 0.0099
Ra-226  4.807E+00 0.2234  2.066E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.418E-01 0.0066
Ra-228  3.940E+00 0.1831  3.495E-02 0.0016  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.492E-02 0.0035
Th-228  7.214E-01 0.0335  9.812E-03 0.0005  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.921E-03 0.0004
Th-230  1.098E-02 0.0005  5.674E-02 0.0026  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.312E-02 0.0015
Th-232  2.318E+00 0.1077  3.015E-01 0.0140  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.155E-01 0.0100
U-234   1.784E-04 0.0000  2.285E-02 0.0011  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.688E-02 0.0008
U-235   3.298E-01 0.0153  2.132E-02 0.0010  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.600E-02 0.0007
U-238   5.891E-02 0.0027  2.042E-02 0.0009  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.605E-02 0.0007
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.784E+01 0.8292  1.606E+00 0.0746  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.069E+00 0.0962
```

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RESRAD, Version 5.82     T½ Limit = 0.5 year        10/15/99  11:40    Page  20
Summary : SEAD-63 Construction Worker - Site Specific Parameters
File    : CONSTMAX.RAD

                    Total Dcse Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                 Water Dependent Pathways

             Water              Fish               Radon              Plant              Meat               Milk           All Pathways*
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.464E+00 0.1145
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.062E-03 0.0001
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.618E+00 0.1682
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.302E+00 0.0605
H-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.768E-07 0.0000
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.781E-01 0.0176
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.871E-01 0.0133
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.869E-01 0.0133
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.950E+00 0.2301
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.050E+00 0.1882
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.391E-01 0.0344
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.008E-01 0.0047
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.835E+00 0.1318
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.991E-02 0.0019
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.671E-01 0.0171
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.538E-02 0.0044
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.152E+01 1.0000

*Sum of all water independent and dependent pathways.
```

```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                         Water Independent Pathways (Inhalation excludes radon)

             Ground             Inhalation            Radon               Plant               Meat                Milk                Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------   --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Ac-227  6.173E-01 0.0322  8.266E-01 0.0431  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.276E-01 0.0327
Co-57   1.926E-05 0.0000  1.378E-10 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.182E-09 0.0000
Co-60   1.874E+00 0.0976  1.023E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.331E-04 0.0000
Cs-137  1.158E+00 0.0603  4.404E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.380E-03 0.0001
H-3     0.000E+00 0.0000  7.228E-10 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.473E-11 0.0000
Pb-210  1.996E-03 0.0001  2.942E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.178E-01 0.0166
Pu-239  1.307E-04 0.0000  7.463E-02 0.0039  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.123E-01 0.0111
Pu-240  6.755E-05 0.0000  7.457E-02 0.0039  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.121E-01 0.0110
Ra-226  4.777E+00 0.2488  2.547E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.942E-01 0.0101
Ra-228  2.562E+00 0.1334  2.468E-02 0.0013  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.538E-02 0.0024
Th-228  1.179E-01 0.0061  1.603E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.294E-03 0.0001
Th-230  2.136E-02 0.0011  5.675E-02 0.0030  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.348E-02 0.0017
Th-232  4.286E+00 0.2233  3.199E-01 0.0167  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.514E-01 0.0131
U-234   1.781E-04 0.0000  2.272E-02 0.0012  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.679E-02 0.0009
U-235   3.280E-01 0.0171  2.124E-02 0.0011  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.600E-02 0.0008
U-238   5.857E-02 0.0031  2.030E-02 0.0011  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.595E-02 0.0008
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.580E+01 0.8231  1.448E+00 0.0755  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.947E+00 0.1014
```

```
                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                   Water Dependent Pathways

            Water               Fish                Radon               Plant               Meat                Milk             All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.071E+00 0.1079
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.927E-05 0.0000
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.874E+00 0.0976
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.160E+00 0.0604
H-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.376E-10 0.0000
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.228E-01 0.0168
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.870E-01 0.0150
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.868E-01 0.0149
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.973E+00 0.2591
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.632E+00 0.1371
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.208E-01 0.0063
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.116E-01 0.0058
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.858E+00 0.2530
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.968E-02 0.0021
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.652E-01 0.0190
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.483E-02 0.0049
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.920E+01 1.0000

*Sum of all water independent and dependent pathways.
```

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Summary : SEAL 03 Construction Worker - Site Specific Parameters
File    : CONSTMAX.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                       Water Independent Pathways (Inhalation excludes radon)

               Ground              Inhalation             Radon                Plant                Meat                 Milk                 Soil
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227   3.667E-01  0.0225   4.911E-01  0.0301   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.729E-01  0.0229
Co-57    1.572E-11  0.0000   1.125E-16  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.044E-15  0.0000
Co-60    2.604E-01  0.0160   1.421E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.019E-05  0.0000
Cs-137   8.178E-01  0.0501   3.112E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.681E-03  0.0001
H-3      0.000E+00  0.0000   5.382E-18  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.097E-19  0.0000
Pb-210   1.241E-03  0.0001   1.830E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.977E-01  0.0121
Pu-239   1.306E-04  0.0000   7.456E-02  0.0046   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.121E-01  0.0130
Pu-240   6.741E-05  0.0000   7.442E-02  0.0046   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.117E-01  0.0130
Ra-226   4.688E+00  0.2874   3.580E-03  0.0002   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.074E-01  0.0188
Ra-228   4.427E-01  0.0271   4.376E-03  0.0003   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   7.655E-03  0.0005
Th-228   5.142E-04  0.0000   6.994E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.646E-06  0.0000
Th-230   5.210E-02  0.0032   5.676E-02  0.0035   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.514E-02  0.0022
Th-232   6.507E+00  0.3989   3.416E-01  0.0209   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.901E-01  0.0178
U-234    1.799E-04  0.0000   2.233E-02  0.0014   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.650E-02  0.0010
U-235    3.225E-01  0.0198   2.110E-02  0.0013   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.603E-02  0.0010
U-238    5.757E-02  0.0035   1.996E-02  0.0012   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.568E-02  0.0010
=======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total    1.352E+01  0.8286   1.112E+00  0.0681   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.685E+00  0.1033
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```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                        Water Dependent Pathways

             Water                Fish               Radon               Plant                Meat                Milk           All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.231E+00  0.0754
Co-57    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.572E-11  0.0000
Co-60    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.605E-01  0.0160
Cs-137   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.195E-01  0.0502
H-3      0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.491E-18  0.0000
Pb-210   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.007E-01  0.0123
Pu-239   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.868E-01  0.0176
Pu-240   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.862E-01  0.0175
Ra-226   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.999E+00  0.3064
Ra-228   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.547E-01  0.0279
Th-228   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.268E-04  0.0000
Th-230   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.440E-01  0.0088
Th-232   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   7.139E+00  0.4376
U-234    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.901E-02  0.0024
U-235    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.596E-01  0.0220
U-238    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   9.320E-02  0.0057
=======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.631E+01  1.0000

*Sum of all water independent and dependent pathways.
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                       Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                        Water Independent Pathways (Inhalation excludes radon)

                 Ground            Inhalation            Radon               Plant               Meat                Milk                Soil
Radio-     ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide    mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
-------    ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227     2.179E-01  0.0143   2.918E-01  0.0191   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.215E-01  0.0145
Co-57      1.282E-17  0.0000   9.177E-23  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.116E-21  0.0000
Co-60      3.619E-02  0.0024   1.976E-07  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.365E-06  0.0000
Cs-137     5.778E-01  0.0378   2.198E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.188E-03  0.0001
H-3        0.000E+00  0.0000   3.961E-26  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.075E-28  0.0000
Pb-210     7.721E-04  0.0001   1.138E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.229E-01  0.0080
Pu-239     1.305E-04  0.0000   7.450E-02  0.0049   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.119E-01  0.0139
Pu-240     6.727E-05  0.0000   7.427E-02  0.0049   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.113E-01  0.0138
Ra-226     4.601E+00  0.3012   4.185E-03  0.0003   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.742E-01  0.0245
Ra-228     7.181E-02  0.0047   7.102E-04  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.241E-03  0.0001
Th-228     2.243E-06  0.0000   3.051E-08  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.463E-08  0.0000
Th-230     8.227E-02  0.0054   5.677E-02  0.0037   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.737E-02  0.0024
Th-232     6.876E+00  0.4502   3.453E-01  0.0226   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.965E-01  0.0194
U-234      1.859E-04  0.0000   2.195E-02  0.0014   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.622E-02  0.0011
U-235      3.171E-01  0.0208   2.102E-02  0.0014   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.612E-02  0.0011
U-238      5.658E-02  0.0037   1.961E-02  0.0013   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.541E-02  0.0010
=======    =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total      1.284E+01  0.8404   9.112E-01  0.0597   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.526E+00  0.0999
```

```
                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                         As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                                               Water Dependent Pathways

                 Water                Fish                Radon                Plant                Meat                 Milk              All Pathways*
Radio-   ------------------- ------------------- ------------------- ------------------- ------------------- ------------------- -------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
-------  ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------
Ac-227   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.312E-01 0.0479
Co-57    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.283E-17 0.0000
Co-60    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.620E-02 0.0024
Cs-137   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.790E-01 0.0379
H-3      0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.042E-26 0.0000
Pb-210   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.248E-01 0.0082
Pu-239   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.865E-01 0.0188
Pu-240   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.856E-01 0.0187
Ra-226   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.979E+00 0.3260
Ra-228   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.376E-02 0.0048
Th-228   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.298E-06 0.0000
Th-230   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.764E-01 0.0115
Th-232   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.518E+00 0.4922
U-234    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.836E-02 0.0025
U-235    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.542E-01 0.0232
U-238    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.160E-02 0.0060
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.527E+01 1.0000

*Sum of all water independent and dependent pathways.
```

```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                         Water Independent Pathways (Inhalation excludes radon)

            Ground          Inhalation          Radon             Plant              Meat              Milk              Soil
Radio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
Nuclide mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Ac-227  1.295E-01 0.0088  1.734E-01 0.0118  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.316E-01 0.0089
Co-57   1.046E-23 0.0000  7.488E-29 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.358E-27 0.0000
Co-60   5.030E-03 0.0003  2.746E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.163E-06 0.0000
Cs-137  4.082E-01 0.0278  1.553E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.392E-04 0.0001
H-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
Pb-210  4.802E-04 0.0000  7.078E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.645E-02 0.0052
Pu-239  1.303E-04 0.0000  7.443E-02 0.0051  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.117E-01 0.0144
Pu-240  6.714E-05 0.0000  7.412E-02 0.0050  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.108E-01 0.0143
Ra-226  4.515E+00 0.3070  4.525E-03 0.0003  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.124E-01 0.0280
Ra-228  1.163E-02 0.0008  1.150E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.009E-04 0.0000
Th-228  9.785E-09 0.0000  1.331E-10 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.074E-10 0.0000
Th-230  1.119E-01 0.0076  5.679E-02 0.0039  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.993E-02 0.0027
Th-232  6.936E+00 0.4716  3.458E-01 0.0235  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.975E-01 0.0202
U-234   1.957E-04 0.0000  2.158E-02 0.0015  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.595E-02 0.0011
U-235   3.119E-01 0.0212  2.099E-02 0.0014  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.623E-02 0.0011
U-238   5.561E-02 0.0038  1.928E-02 0.0013  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.515E-02 0.0010
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.249E+01 0.8490  7.918E-01 0.0538  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.429E+00 0.0972
```

```
                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                      Water Dependent Pathways

             Water                 Fish                 Radon                Plant                Meat                 Milk              All Pathways*
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.344E-01 0.0295
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.047E-23 0.0000
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.031E-03 0.0003
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.090E-01 0.0278
H-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.764E-02 0.0053
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.863E-01 0.0195
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.850E-01 0.0194
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.932E+00 0.3354
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.194E-02 0.0008
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.003E-08 0.0000
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.086E-01 0.0142
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.579E+00 0.5154
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.773E-02 0.0026
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.491E-01 0.0237
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.003E-02 0.0061
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.471E+01 1.0000

*Sum of all water independent and dependent pathways.
```

```
RESRAD, Ver       2     T½ Limit = 0.5 year        10/15/99  11:4       age  29
Summary : SEAD    Construction Worker - Site Specific Parameters
File    : CONSTMAX.RAD

                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                        As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                           Water Independent Pathways (Inhalation excludes radon)

           Ground           Inhalation          Radon              Plant              Meat               Milk               Soil
adio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
uclide mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------ --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
c-227  7.691E-02 0.0054  1.030E-01 0.0072  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.819E-02 0.0055
o-57   8.537E-30 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
o-60   6.991E-04 0.0000  3.816E-09 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.616E-07 0.0000
s-137  2.884E-01 0.0201  1.097E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.929E-04 0.0000
-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
b-210  2.987E-04 0.0000  4.402E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.755E-02 0.0033
u-239  1.302E-04 0.0000  7.437E-02 0.0052  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.115E-01 0.0148
u-240  6.700E-05 0.0000  7.397E-02 0.0052  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.104E-01 0.0147
a-226  4.431E+00 0.3091  4.701E-03 0.0003  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.328E-01 0.0302
a-228  1.883E-03 0.0001  1.862E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.254E-05 0.0000
h-228  4.268E-11 0.0000  5.806E-13 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.687E-13 0.0000
h-230  1.409E-01 0.0098  5.682E-02 0.0040  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.268E-02 0.0030
h-232  6.945E+00 0.4845  3.459E-01 0.0241  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.977E-01 0.0208
-234   2.092E-04 0.0000  2.122E-02 0.0015  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.568E-02 0.0011
-235   3.067E-01 0.0214  2.098E-02 0.0015  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.635E-02 0.0011
-238   5.465E-02 0.0038  1.895E-02 0.0013  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.489E-02 0.0010
====== ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
otal   1.225E+01 0.8543  7.204E-01 0.0503  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.368E+00 0.0955
```

```
                             Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                          As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                               Water Dependent Pathways

              Water                Fish                Radon                Plant                Meat                 Milk             All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------

Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.581E-01 0.0180
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.537E-30 0.0000
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.993E-04 0.0000
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.890E-01 0.0202
H-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.829E-02 0.0034
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.860E-01 0.0200
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.844E-01 0.0198
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.868E+00 0.3396
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.934E-03 0.0001
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.373E-11 0.0000
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.404E-01 0.0168
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.589E+00 0.5294
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.711E-02 0.0026
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.441E-01 0.0240
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.848E-02 0.0062
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.434E+01 1.0000

*Sum of all water independent and dependent pathways.
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                          Dose/Source Ratios Summed Over All Pathways
                   Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                                  DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)       (j)    Fraction*  t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
-------  -------  ---------     --------- --------- --------- --------- --------- --------- --------- ---------
Ac-227   Ac-227   1.000E+00     2.931E+00 2.831E+00 2.464E+00 2.071E+00 1.231E+00 7.312E-01 4.344E-01 2.581E-01

Co-57    Co-57    1.000E+00     2.207E-01 8.667E-02 2.062E-03 1.927E-05 1.572E-11 1.283E-17 1.047E-23 8.540E-30

Co-60    Co-60    1.000E+00     6.985E+00 6.124E+00 3.618E+00 1.874E+00 2.605E-01 3.620E-02 5.031E-03 6.993E-04

Cs-137   Cs-137   1.000E+00     1.462E+00 1.429E+00 1.302E+00 1.160E+00 8.195E-01 5.790E-01 4.090E-01 2.890E-01

H-3      H-3      1.000E+00     1.922E-04 5.524E-05 3.768E-07 7.376E-10 5.491E-18 4.042E-26 2.941E-34 2.116E-42

Pb-210   Pb-210   1.000E+00     4.430E-01 4.292E-01 3.781E-01 3.228E-01 2.007E-01 1.248E-01 7.764E-02 4.829E-02

Pu-239   Pu-239   1.000E+00     2.872E-01 2.872E-01 2.871E-01 2.870E-01 2.868E-01 2.865E-01 2.863E-01 2.860E-01
Pu-239   U-235    1.000E+00     0.000E+00 3.633E-10 1.812E-09 3.614E-09 8.952E-09 1.419E-08 1.934E-08 2.440E-08
Pu-239   Pa-231   1.000E+00     0.000E+00 9.810E-15 2.445E-13 9.740E-13 6.015E-12 1.522E-11 2.843E-11 4.550E-11
Pu-239   Ac-227   1.000E+00     0.000E+00 3.211E-16 3.869E-14 2.960E-13 4.068E-12 1.478E-11 3.433E-11 6.369E-11
Pu-239   ∑DSR(j)                2.872E-01 2.872E-01 2.871E-01 2.870E-01 2.868E-01 2.865E-01 2.863E-01 2.860E-01

Pu-240   Pu-240   1.000E+00     2.871E-01 2.871E-01 2.869E-01 2.868E-01 2.862E-01 2.856E-01 2.850E-01 2.844E-01
Pu-240   U-236    1.000E+00     0.000E+00 1.124E-09 5.605E-09 1.117E-08 2.767E-08 4.384E-08 5.971E-08 7.527E-08
Pu-240   Th-232   1.000E+00     0.000E+00 3.281E-19 8.188E-18 3.268E-17 2.029E-16 5.162E-16 9.697E-16 1.561E-15
Pu-240   Ra-228   1.000E+00     0.000E+00 7.592E-20 8.448E-18 5.908E-17 6.562E-16 2.050E-15 4.270E-15 7.308E-15
Pu-240   Th-228   1.000E+00     0.000E+00 1.093E-20 4.807E-18 5.251E-17 8.516E-16 2.960E-15 6.468E-15 1.137E-14
Pu-240   ∑DSR(j)                2.871E-01 2.871E-01 2.869E-01 2.868E-01 2.862E-01 2.856E-01 2.850E-01 2.844E-01

Ra-226   Ra-226   1.000E+00     4.918E+00 4.912E+00 4.887E+00 4.856E+00 4.765E+00 4.676E+00 4.589E+00 4.503E+00
Ra-226   Pb-210   1.000E+00     0.000E+00 1.354E-02 6.347E-02 1.172E-01 2.336E-01 3.030E-01 3.432E-01 3.653E-01
Ra-226   ∑DSR(j)                4.918E+00 4.925E+00 4.950E+00 4.973E+00 4.999E+00 4.979E+00 4.932E+00 4.868E+00

Ra-228   Ra-228   1.000E+00     2.667E+00 2.362E+00 1.454E+00 7.924E-01 1.283E-01 2.078E-02 3.364E-03 5.448E-04
Ra-228   Th-228   1.000E+00     0.000E+00 1.290E+00 2.596E+00 1.839E+00 3.264E-01 5.298E-02 8.580E-03 1.389E-03
Ra-228   ∑DSR(j)                2.667E+00 3.652E+00 4.050E+00 2.632E+00 4.547E-01 7.376E-02 1.194E-02 1.934E-03

Th-228   Th-228   1.000E+00     4.524E+00 3.149E+00 7.391E-01 1.208E-01 5.268E-04 2.298E-06 1.003E-08 4.373E-11

Th-230   Th-230   1.000E+00     9.016E-02 9.016E-02 9.015E-02 9.015E-02 9.013E-02 9.012E-02 9.011E-02 9.009E-02
Th-230   Ra-226   1.000E+00     0.000E+00 2.129E-03 1.062E-02 2.117E-02 5.243E-02 8.309E-02 1.132E-01 1.427E-01
Th-230   Pb-210   1.000E+00     0.000E+00 2.950E-06 1.063E-05 2.679E-04 1.440E-03 3.203E-03 5.314E-03 7.623E-03
Th-230   ∑DSR(j)                9.016E-02 9.229E-02 1.008E-01 1.116E-01 1.440E-01 1.764E-01 2.086E-01 2.404E-01

Th-232   Th-232   1.000E+00     4.495E-01 4.495E-01 4.495E-01 4.495E-01 4.495E-01 4.495E-01 4.495E-01 4.495E-01
Th-232   Ra-228   1.000E+00     0.000E+00 3.028E-01 1.205E+00 1.862E+00 2.522E+00 2.628E+00 2.646E+00 2.648E+00
Th-232   Th-228   1.000E+00     0.000E+00 8.431E-02 1.180E+00 2.546E+00 4.168E+00 4.440E+00 4.484E+00 4.491E+00
Th-232   ∑DSR(j)                4.495E-01 8.366E-01 2.835E+00 4.858E+00 7.139E+00 7.518E+00 7.579E+00 7.589E+00
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                        Dose/Source Ratios Summed Over All Pathways
                  Parent and Progeny Principal Radionuclide Contributions Indicated

Parent  Product  Branch                           DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)      (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ ______  _________     _________ _________ _________ _________ _________ _________ _________ _________

U-234   U-234   1.000E+00     4.013E-02 4.009E-02 3.990E-02 3.967E-02 3.899E-02 3.832E-02 3.766E-02 3.701E-02
U-234   Th-230  1.000E+00     0.000E+00 8.111E-07 4.046E-06 8.069E-06 2.000E-05 3.172E-05 4.323E-05 5.455E-05
U-234   Ra-226  1.000E+00     0.000E+00 9.581E-09 2.388E-07 9.512E-07 5.873E-06 1.485E-05 2.775E-05 4.441E-05
U-234   Pb-210  1.000E+00     0.000E+00 8.874E-12 1.072E-09 8.233E-09 1.142E-07 4.183E-07 9.787E-07 1.827E-06
U-234   ∑DSR(j)               4.013E-02 4.009E-02 3.991E-02 3.968E-02 3.901E-02 3.836E-02 3.773E-02 3.711E-02

U-235   U-235   1.000E+00     3.691E-01 3.687E-01 3.670E-01 3.649E-01 3.586E-01 3.525E-01 3.464E-01 3.405E-01
U-235   Pa-231  1.000E+00     0.000E+00 1.991E-05 9.910E-05 1.971E-04 4.841E-04 7.611E-04 1.028E-03 1.286E-03
U-235   Ac-227  1.000E+00     0.000E+00 9.751E-07 2.322E-05 8.752E-05 4.617E-04 1.010E-03 1.650E-03 2.334E-03
U-235   ∑DSR(j)               3.691E-01 3.687E-01 3.671E-01 3.652E-01 3.596E-01 3.542E-01 3.491E-01 3.441E-01

U-238   U-238   1.000E+00     9.593E-02 9.582E-02 9.538E-02 9.483E-02 9.320E-02 9.160E-02 9.002E-02 8.848E-02
U-238   U-234   1.000E+00     0.000E+00 1.136E-07 5.656E-07 1.125E-06 2.763E-06 4.345E-06 5.872E-06 7.345E-06
U-238   Th-230  1.000E+00     0.000E+00 1.150E-12 2.865E-11 1.142E-10 7.052E-10 1.785E-09 3.335E-09 5.340E-09
U-238   Ra-226  1.000E+00     0.000E+00 9.068E-15 1.128E-12 8.981E-12 1.385E-10 5.595E-10 1.435E-09 2.920E-09
U-238   Pb-210  1.000E+00     0.000E+00 7.404E-18 3.829E-15 5.918E-14 2.093E-12 1.248E-11 4.078E-11 9.821E-11
U-238   ∑DSR(j)               9.593E-02 9.582E-02 9.538E-02 9.483E-02 9.320E-02 9.160E-02 9.003E-02 8.848E-02
_______ _______ _________     _________ _________ _________ _________ _________ _________ _________ _________
*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.


                        Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                              Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)     t= 0.000E+00    1.000E+00    5.000E+00    1.000E+01    2.500E+01    4.000E+01    5.500E+01    7.000E+01
_______      _________    _________    _________    _________    _________    _________    _________    _________

Ac-227       3.412E+00    3.532E+00    4.058E+00    4.827E+00    8.125E+00    1.368E+01    2.302E+01    3.874E+01
Co-57        4.531E+01    1.154E+02    4.849E+03    5.190E+05    6.361E+11   *8.464E+15   *8.464E+15   *8.464E+15
Co-60        1.432E+00    1.633E+00    2.764E+00    5.336E+00    3.839E+01    2.762E+02    1.988E+03    1.430E+04
Cs-137       6.839E+00    6.999E+00    7.678E+00    8.621E+00    1.220E+01    1.727E+01    2.445E+01    3.460E+01
H-3          5.202E+04    1.810E+05    2.654E+07    1.356E+10   *9.594E+15   *9.594E+15   *9.594E+15   *9.594E+15
Pb-210       2.257E+01    2.330E+01    2.645E+01    3.098E+01    4.982E+01    8.010E+01    1.288E+02    2.071E+02
Pu-239       3.482E+01    3.482E+01    3.483E+01    3.484E+01    3.487E+01    3.490E+01    3.493E+01    3.496E+01
Pu-240       3.483E+01    3.483E+01    3.485E+01    3.487E+01    3.494E+01    3.502E+01    3.509E+01    3.516E+01
Ra-226       2.033E+00    2.030E+00    2.020E+00    2.011E+00    2.000E+00    2.008E+00    2.028E+00    2.054E+00
Ra-228       3.749E+00    2.738E+00    2.469E+00    3.800E+00    2.199E+01    1.356E+02    8.372E+02    5.170E+03
Th-228       2.211E+00    3.176E+00    1.353E+01    8.280E+01    1.898E+04    4.351E+06    9.975E+08    2.287E+11
Th-230       1.109E+02    1.084E+02    9.916E+01    8.962E+01    6.944E+01    5.668E+01    4.794E+01    4.159E+01
Th-232       2.225E+01    1.195E+01    3.528E+00    2.059E+00    1.401E+00    1.330E+00    1.319E+00    1.318E+00
U-234        2.492E+02    2.494E+02    2.506E+02    2.520E+02    2.563E+02    2.607E+02    2.651E+02    2.695E+02
U-235        2.709E+01    2.712E+01    2.724E+01    2.738E+01    2.781E+01    2.823E+01    2.865E+01    2.906E+01
U-238        1.042E+02    1.044E+02    1.048E+02    1.054E+02    1.073E+02    1.092E+02    1.111E+02    1.130E+02
_______      _________    _________    _________    _________    _________    _________    _________    _________
*At specific activity limit
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RESRAD OUTPUT FOR PARK WORKER – SOIL SUPPORT FOR DERIVATION OF CLEAN UP GOAL

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                  Dose Conversion Factor (and Related) Parameter Summary (continued)
                                         File: DOSFAC.BIN

     |                                                        |  Current  |           |  Parameter
Menu |                     Parameter                          |   Value   |  Default  |    Name
-----+--------------------------------------------------------+-----------+-----------+------------
D-34 | Co-60     , plant/soil concentration ratio, dimensionless | 8.000E-02 | 8.000E-02 | RTF( 3,1)
D-34 | Co-60     , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-02 | 2.000E-02 | RTF( 3,2)
D-34 | Co-60     , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 2.000E-03 | 2.000E-03 | RTF( 3,3)
D-34 |                                                           |           |           |
D-34 | Cs-137+D  , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 4,1)
D-34 | Cs-137+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 4,2)
D-34 | Cs-137+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 8.000E-03 | 8.000E-03 | RTF( 4,3)
D-34 |                                                           |           |           |
D-34 | H-3       , plant/soil concentration ratio, dimensionless | 4.800E+00 | 4.800E+00 | RTF( 5,1)
D-34 | H-3       , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.200E-02 | 1.200E-02 | RTF( 5,2)
D-34 | H-3       , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-02 | 1.000E-02 | RTF( 5,3)
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Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

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RESRAD, Version 5.82     T½ Limit = 0.5 year        10/15/99  12:06    Page   2
Summary : SEAD-63 Park Worker - Site Specific Parameters         File: INDUS.RAD

                     Dose Conversion Factor (and Related) Parameter Summary
                                     File: DOSFAC.BIN

     |                                                          | Current   |           | Parameter
Menu |                         Parameter                        |  Value    |  Default  |   Name
-----+----------------------------------------------------------+-----------+-----------+-----------
B-1  | Dose conversion factors for inhalation, mrem/pCi:        |           |           |
B-1  | Ac-227+D                                                 | 6.720E+00 | 6.720E+00 | DCF2( 1)
B-1  | Co-57                                                    | 9.070E-06 | 9.070E-06 | DCF2( 2)
B-1  | Co-60                                                    | 2.190E-04 | 2.190E-04 | DCF2( 3)
B-1  | Cs-137+D                                                 | 3.190E-05 | 3.190E-05 | DCF2( 4)
B-1  | H-3                                                      | 6.400E-08 | 6.400E-08 | DCF2( 5)
B-1  | Pa-231                                                   | 1.280E+00 | 1.280E+00 | DCF2( 6)
                                                                | 2.320E-02 | 2.320E-02 | DCF2( 7)
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RESRAD, Version 5.82     T½ Limit = 0.5 year        10/15/99  12:06    Page   4
Summary : SEAD-63 Park Worker - Site Specific Parameters         File: INDUS.RAD

              Dose Conversion Factor (and Related) Parameter Summary (continued)
                                     File: DOSFAC.BIN

     |                                                          | Current   |           | Parameter
Menu |                         Parameter                        |  Value    |  Default  |   Name
-----+----------------------------------------------------------+-----------+-----------+-----------
D-34 | U-235+D  , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(16,1)
D-34 | U-235+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF(16,2)
D-34 | U-235+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF(16,3)
D-34 |                                                          |           |           |
D-34 | U-236    , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(17,1)
D-34 | U-236    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF(17,2)
D-34 | U-236    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF(17,3)
D-34 |                                                          |           |           |
D-34 | U-238+D  , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(18,1)
D-34 | U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF(18,2)
D-34 | U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF(18,3)
     |                                                          |           |           |
D-5  | Bioaccumulation factors, fresh water, L/kg:              |           |           |
D-5  | Ac-227+D , fish                                          | 1.500E+01 | 1.500E+01 | BIOFAC( 1,1)
D-5  | Ac-227+D , crustacea and mollusks                        | 1.000E+03 | 1.000E+03 | BIOFAC( 1,2)
D-5  |                                                          |           |           |
D-5  | Co-57    , fish                                          | 3.000E+02 | 3.000E+02 | BIOFAC( 2,1)
D-5  | Co-57    , crustacea and mollusks                        | 2.000E+02 | 2.000E+02 | BIOFAC( 2,2)
D-5  |                                                          |           |           |
D-5  | Co-60    , fish                                          | 3.000E+02 | 3.000E+02 | BIOFAC( 3,1)
D-5  | Co-60    , crustacea and mollusks                        | 2.000E+02 | 2.000E+02 | BIOFAC( 3,2)
D-5  |                                                          |           |           |
D-5  | Cs-137+D , fish                                          | 2.000E+03 | 2.000E+03 | BIOFAC( 4,1)
D-5  | Cs-137+D , crustacea and mollusks                        | 1.000E+02 | 1.000E+02 | BIOFAC( 4,2)
D-5  |                                                          |           |           |
D-5  | H-3      , fish                                          | 1.000E+00 | 1.000E+00 | BIOFAC( 5,1)
D-5  | H-3      , crustacea and mollusks                        | 1.000E+00 | 1.000E+00 | BIOFAC( 5,2)
D-5  |                                                          |           |           |
D-5  | Pa-231   , fish                                          | 1.000E+01 | 1.000E+01 | BIOFAC( 6,1)
D-5  | Pa-231   , crustacea and mollusks                        | 1.100E+02 | 1.100E+02 | BIOFAC( 6,2)
D-5  |                                                          |           |           |
D-5  | Pb-210+D , fish                                          | 3.000E+02 | 3.000E+02 | BIOFAC( 7,1)
D-5  | Pb-210+    crustacea and mollusks                        | 1.000E+02 | 1.000E+02 | BIOFAC( 7,2)
D-5  |                                                          |           |           |
D-5  | Pu-23    , fish                                          |  .000E+01 | 3.000E+01 | BIOFAC( 8,1)
D-5  | Pu-23.   , crustacea and mollusks                        |  .000E+02 | 1.000E+02 | BIOFAC( 8,2)
D-5  |                                                          |           |           |
```

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(14,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(14,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(15,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(15,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(16,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(16,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(17,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(17,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(18,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(18,2)

```
                                                            Site-Specific Parameter Summary

     |                                                            | User       |            |          Used by RESRAD              | Parameter
Menu |                         Parameter                          | Input      |  Default   |  (If different from user input)      |   Name
-----+------------------------------------------------------------+------------+------------+--------------------------------------+-----------
R011 | Area of contaminated zone (m**2)                           | 3.439E+03  | 1.000E+04  |                ---                   | AREA
R011 | Thickness of contaminated zone (m)                         | 2.000E+00  | 2.000E+00  |                ---                   | THICK0
R011 | Length parallel to aquifer flow (m)                        | 6.100E+01  | 1.000E+02  |                ---                   | LCZPAQ
R011 | Basic radiation dose limit (mrem/yr)                       | 1.000E+01  | 3.000E+01  |                ---                   | BRDL
R011 | Time since placement of material (yr)                      | 0.000E+00  | 0.000E+00  |                ---                   | TI
R011 | Times for calculations (yr)                                | 1.000E+00  | 1.000E+00  |                ---                   | T( 2)
R011 | Times for calculations (yr)                                | 5.000E+00  | 3.000E+00  |                ---                   | T( 3)
R011 | Times for calculations (yr)                                | 1.000E+01  | 1.000E+01  |                ---                   | T( 4)
R011 | Times for calculations (yr)                                | 2.500E+01  | 3.000E+01  |                ---                   | T( 5)
R011 | Times for calculations (yr)                                | 4.000E+01  | 1.000E+02  |                ---                   | T( 6)
R011 | Times for calculations (yr)                                | 5.500E+01  | 3.000E+02  |                ---                   | T( 7)
R011 | Times for calculations (yr)                                | 7.000E+01  | 1.000E+03  |                ---                   | T( 8)
R011 | Times for calculations (yr)                                | not used   | 0.000E+00  |                ---                   | T( 9)
R011 | Times for calculations (yr)                                | not used   | 0.000E+00  |                ---                   | T(10)
     |                                                            |            |            |                                      |
R012 | Initial principal radionuclide (pCi/g):  Ac-227            | 1.000E+00  | 0.000E+00  |                ---                   | S1( 1)
R012 | Initial principal radionuclide (pCi/g):  Co-57             | 1.000E+00  | 0.000E+00  |                ---                   | S1( 2)
R012 | Initial principal radionuclide (pCi/g):  Co-60             | 1.000E+00  | 0.000E+00  |                ---                   | S1( 3)
R012 | Initial principal radionuclide (pCi/g):  Cs-137            | 1.000E+00  | 0.000E+00  |                ---                   | S1( 4)
R012 | Initial principal radionuclide (pCi/g):  H-3               | 1.000E+00  | 0.000E+00  |                ---                   | S1( 5)
R012 | Initial principal radionuclide (pCi/g):  Pa-231            | 1.000E+00  | 0.000E+00  |                ---                   | S1( 6)
R012 | Initial principal radionuclide (pCi/g):  Pb-210            | 1.000E+00  | 0.000E+00  |                ---                   | S1( 7)
R012 | Initial principal radionuclide (pCi/g):  Pu-239            | 1.000E+00  | 0.000E+00  |                ---                   | S1( 8)
R012 | Initial principal radionuclide (pCi/g):  Pu-240            | 1.000E+00  | 0.000E+00  |                ---                   | S1( 9)
R012 | Initial principal radionuclide (pCi/g):  Ra-226            | 1.000E+00  | 0.000E+00  |                ---                   | S1(10)
R012 | Initial principal radionuclide (pCi/g):  Ra-228            | 1.000E+00  | 0.000E+00  |                ---                   | S1(11)
R012 | Initial principal radionuclide (pCi/g):  Th-228            | 1.000E+00  | 0.000E+00  |                ---                   | S1(12)
R012 | Initial principal radionuclide (pCi/g):  Th-230            | 1.000E+00  | 0.000E+00  |                ---                   | S1(13)
R012 | Initial principal radionuclide (pCi/g):  Th-232            | 1.000E+00  | 0.000E+00  |                ---                   | S1(14)
R012 | Initial principal radionuclide (pCi/g):  U-234             | 1.000E+00  | 0.000E+00  |                ---                   | S1(15)
R012 | Initial principal radionuclide (pCi/g):  U-235             | 1.000E+00  | 0.000E+00  |                ---                   | S1(16)
R012 | Initial principal radionuclide (pCi/g):  U-238             | 1.000E+00  | 0.000E+00  |                ---                   | S1(18)
R012 | Concentration in groundwater   (pCi/L):  Ac-227            | not used   | 0.000E+00  |                ---                   | W1( 1)
R012 | Concentration in groundwater   (pCi/L):  Co-57             | not used   | 0.000E+00  |                ---                   | W1( 2)
R012 | Concentration in groundwater   (pCi/L):  Co-60             | not used   | 0.000E+00  |                ---                   | W1( 3)
R012 | Concentration in groundwater   (pCi/L):  Cs-137            | not used   | 0.000E+00  |                ---                   | W1( 4)
R012 | Concentration in groundwater   (pCi/L):  H-3               | not used   | 0.000E+00  |                ---                   | W1( 5)
R012 | Concentration in groundwater   (pCi/L):  Pa-231            | not used   | 0.000E+00  |                ---                   | W1( 6)
R012 | Concentration in groundwater   (pCi/L):  Pb-210            | not used   | 0.000E+00  |                ---                   | W1( 7)
R012 | Concentration in groundwater   (pCi/L):  Pu-239            | not used   | 0.000E+00  |                ---                   | W1( 8)
R012 | Concentration in groundwater   (pCi/L):  Pu-240            | not used   | 0.000E+00  |                ---                   | W1( 9)
R012 | Concentration in groundwater   (pCi/L):  Ra-226            | not used   | 0.000E+00  |                ---                   | W1(10)
R012 | Concentration in groundwater   (pCi/L):  Ra-228            | not used   | 0.000E+00  |                ---                   | W1(11)
R012 | Concentration in groundwater   (pCi/L):  Th-228            | not used   | 0.000E+00  |                ---                   | W1(12)
R012 | Concentration in groundwater   (pCi/L):  Th-230            | not used   | 0.000E+00  |                ---                   | W1(13)
R012 | Concentration in groundwater   (pCi/L):  Th-232            | not used   | 0.000E+00  |                ---                   | W1(14)
R012 | Concentration in groundwater   (pCi/L):  U-234             | not used   | 0.000E+00  |                ---                   | W1(15)
R012 | Concentration in groundwater   (pCi/L):  U-235             | not used   | 0.000E+00  |                ---                   | W1(16)
R012 | Concentration in groundwater   (pCi/L):  U-238             | not used   | 0.000E+00  |                ---                   | W1(18)
     |                                                            |            |            |                                      |
R013 | Cover depth (m)                                            | 0.000E+00  | 0.000E+00  |                ---                   | COVER0
```

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                                         Site-Specific Parameter Summary (continued)

      |                                                  |   User     |            |     Used by RESRAD               | Parameter
 Menu |                    Parameter                     |   Input    |  Default   | (If different from user input)   |   Name
------+--------------------------------------------------+------------+------------+----------------------------------+-------------
R013  | Density of cover material (g/cm**3)              | not used   | 1.500E+00  |             ---                  | DENSCV
R013  | Cover depth erosion rate (m/yr)                  | not used   | 1.000E-03  |             ---                  | VCV
R013  | Density of contaminated zone (g/cm**3)           | 1.500E+00  | 1.500E+00  |             ---                  | DENSCZ
R013  | Contaminated zone erosion rate (m/yr)            | 6.000E-05  | 1.000E-03  |             ---                  | VCZ
R013  | Contaminated zone total porosity                 | 3.700E-01  | 4.000E-01  |             ---                  | TPCZ
R013  | Contaminated zone effective porosity             | 1.750E-01  | 2.000E-01  |             ---                  | EPCZ
R013  | Contaminated zone hydraulic conductivity (m/yr)  | 2.080E+02  | 1.000E+01  |             ---                  | HCCZ
R013  | Contaminated zone b parameter                    | 7.750E+00  | 5.300E+00  |             ---                  | BCZ
R013  | Average annual wind speed (m/sec)                | 3.000E+00  | 2.000E+00  |             ---                  | WIND
R013  | Humidity in air (g/m**3)                         | 6.600E+00  | 8.000E+00  |             ---                  | HUMID
R013  | Evapotranspiration coefficient                   | 7.100E-01  | 5.000E-01  |             ---                  | EVAPTR
R013  | Precipitation (m/yr)                             | 7.500E-01  | 1.000E+00  |             ---                  | PRECIP
R013  | Irrigation (m/yr)                                | 0.000E+00  | 2.000E-01  |             ---                  | RI
R013  | Irrigation mode                                  | overhead   | overhead   |             ---                  | IDITCH
R013  | Runoff coefficient                               | 2.000E-01  | 2.000E-01  |             ---                  | RUNOFF
R013  | Watershed area for nearby stream or pond (m**2)  | 1.300E+07  | 1.000E+06  |             ---                  | WAREA
R013  | Accuracy for water/soil computations             | 1.000E-03  | 1.000E-03  |  Romberg failures occurred       | EPS
      |                                                  |            |            |                                  |
R014  | Density of saturated zone (g/cm**3)              | 1.500E+00  | 1.500E+00  |             ---                  | DENSAQ
R014  | Saturated zone total porosity                    | 3.700E-01  | 4.000E-01  |             ---                  | TPSZ
R014  | Saturated zone effective porosity                | 1.750E-01  | 2.000E-01  |             ---                  | EPSZ
R014  | Saturated zone hydraulic conductivity (m/yr)     | 2.080E+02  | 1.000E+02  |             ---                  | HCSZ
R014  | Saturated zone hydraulic gradient                | 1.200E-02  | 2.000E-02  |             ---                  | HGWT
R014  | Saturated zone b parameter                       | 1.040E+01  | 5.300E+00  |             ---                  | BSZ
R014  | Water table drop rate (m/yr)                     | 0.000E+00  | 1.000E-03  |             ---                  | VWT
R014  | Well pump intake depth (m below water table)     | 3.000E+00  | 1.000E+01  |             ---                  | DWIBWT
R014  | Model: Nondispersion (ND) or Mass-Balance (MB)   | ND         | ND         |             ---                  | MODEL
R014  | Well pumping rate (m**3/yr)                      | 5.000E+01  | 2.500E+02  |             ---                  | UW
      |                                                  |            |            |                                  |
R015  | Number of unsaturated zone strata                | 1          | 1          |             ---                  | NS
R015  | Unsat. zone 1, thickness (m)                     | 1.000E+00  | 4.000E+00  |             ---                  | H(1)
R015  | Unsat. zone 1, soil density (g/cm**3)            | 1.500E+00  | 1.500E+00  |             ---                  | DENSUZ(1)
R015  | Unsat. zone 1, total porosity                    | 3.700E-01  | 4.000E-01  |             ---                  | TPUZ(1)
R015  | Unsat. zone 1, effective porosity                | 1.750E-01  | 2.000E-01  |             ---                  | EPUZ(1)
R015  | Unsat. zone 1, soil-specific b parameter         | 1.040E+01  | 5.300E+00  |             ---                  | BUZ(1)
R015  | Unsat. zone 1, hydraulic conductivity (m/yr)     | 2.080E+02  | 1.000E+01  |             ---                  | HCUZ(1)
      |                                                  |            |            |                                  |
R016  | Distribution coefficients for Ac-227             |            |            |                                  |
R016  |   Contaminated zone (cm**3/g)                    | 2.000E+01  | 2.000E+01  |             ---                  | DCNUCC( 1)
R016  |   Unsaturated zone 1 (cm**3/g)                   | 2.000E+01  | 2.000E+01  |             ---                  | DCNUCU( 1,1)
R016  |   Saturated zone (cm**3/g)                       | 2.000E+01  | 2.000E+01  |             ---                  | DCNUCS( 1)
R016  |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |          2.876E-03               | ALEACH( 1)
R016  |   Solubility constant                            | 0.000E+00  | 0.000E+00  |          not used                | SOLUBK( 1)
      |                                                  |            |            |                                  |
R016  | Distribution coefficients for Co-57              |            |            |                                  |
R016  |   Contaminated zone (cm**3/g)                    | 1.000E+03  | 1.000E+03  |             ---                  | DCNUCC( 2)
R016  |   Unsaturated zone 1 (cm**3/g)                   | 1.000E+03  | 1.000E+03  |             ---                  | DCNUCU( 2,1)
R016  |   Saturated zone (cm**3/g)                       | 1.000E+03  | 1.000E+03  |             ---                  | DCNUCS( 2)
R016  |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |          5.799E-05               | ALEACH( 2)
R016  |   Solubility constant                            | 0.000E+00  | 0.000E+00  |          not used                | SOLUBK( 2)
```

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                                        Site-Specific Parameter Summary (continued)

     |                                            |    User    |            |          Used by RESRAD            | Parameter
Menu |                 Parameter                  |   Input    |  Default   |  (If different from user input)   |   Name
-----+--------------------------------------------+------------+------------+-----------------------------------+--------------
R016 | Distribution coefficients for Co-60        |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)              | 1.000E+03  | 1.000E+03  |                ---                | DCNUCC( 3)
R016 |   Unsaturated zone 1 (cm**3/g)             | 1.000E+03  | 1.000E+03  |                ---                | DCNUCU( 3,1)
R016 |   Saturated zone (cm**3/g)                 | 1.000E+03  | 1.000E+03  |                ---                | DCNUCS( 3)
R016 |   Leach rate (/yr)                         | 0.000E+00  | 0.000E+00  |             5.799E-05             | ALEACH( 3)
R016 |   Solubility constant                      | 0.000E+00  | 0.000E+00  |             not used              | SOLUBK( 3)
     |                                            |            |            |                                   |
R016 | Distribution coefficients for Cs-137       |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)              | 1.000E+03  | 1.000E+03  |                ---                | DCNUCC( 4)
R016 |   Unsaturated zone 1 (cm**3/g)             | 1.000E+03  | 1.000E+03  |                ---                | DCNUCU( 4,1)
R016 |   Saturated zone (cm**3/g)                 | 1.000E+03  | 1.000E+03  |                ---                | DCNUCS( 4)
R016 |   Leach rate (/yr)                         | 0.000E+00  | 0.000E+00  |             5.799E-05             | ALEACH( 4)
R016 |   Solubility constant                      | 0.000E+00  | 0.000E+00  |             not used              | SOLUBK( 4)
     |                                            |            |            |                                   |
R016 | Distribution coefficients for H-3          |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)              | 0.000E+00  | 0.000E+00  |                ---                | DCNUCC( 5)
R016 |   Unsaturated zone 1 (cm**3/g)             | 0.000E+00  | 0.000E+00  |                ---                | DCNUCU( 5,1)
R016 |   Saturated zone (cm**3/g)                 | 0.000E+00  | 0.000E+00  |                ---                | DCNUCS( 5)
R016 |   Leach rate (/yr)                         | 0.000E+00  | 0.000E+00  |             3.449E-01             | ALEACH( 5)
R016 |   Solubility constant                      | 0.000E+00  | 0.000E+00  |             not used              | SOLUBK( 5)
     |                                            |            |            |                                   |
R016 | Distribution coefficients for Pa-231       |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)              | 5.000E+01  | 5.000E+01  |                ---                | DCNUCC( 6)
R016 |   Unsaturated zone 1 (cm**3/g)             | 5.000E+01  | 5.000E+01  |                ---                | DCNUCU( 6,1)
R016 |   Saturated zone (cm**3/g)                 | 5.000E+01  | 5.000E+01  |                ---                | DCNUCS( 6)
R016 |   Leach rate (/yr)                         | 0.000E+00  | 0.000E+00  |             1.156E-03             | ALEACH( 6)
R016 |   Solubility constant                      | 0.000E+00  | 0.000E+00  |             not used              | SOLUBK( 6)
     |                                            |            |            |                                   |
R016 | Distribution coefficients for Pb-210       |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)              | 1.000E+02  | 1.000E+02  |                ---                | DCNUCC( 7)
R016 |   Unsaturated zone 1 (cm**3/g)             | 1.000E+02  | 1.000E+02  |                ---                | DCNUCU( 7,1)
R016 |   Saturated zone (cm**3/g)                 | 1.000E+02  | 1.000E+02  |                ---                | DCNUCS( 7)
R016 |   Leach rate (/yr)                         | 0.000E+00  | 0.000E+00  |             5.790E-04             | ALEACH( 7)
R016 |   Solubility constant                      | 0.000E+00  | 0.000E+00  |             not used              | SOLUBK( 7)
     |                                            |            |            |                                   |
R016 | Distribution coefficients for Pu-239       |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)              | 2.000E+03  | 2.000E+03  |                ---                | DCNUCC( 8)
R016 |   Unsaturated zone 1 (cm**3/g)             | 2.000E+03  | 2.000E+03  |                ---                | DCNUCU( 8,1)
R016 |   Saturated zone (cm**3/g)                 | 2.000E+03  | 2.000E+03  |                ---                | DCNUCS( 8)
R016 |   Leach rate (/yr)                         | 0.000E+00  | 0.000E+00  |             2.900E-05             | ALEACH( 8)
R016 |   Solubility constant                      | 0.000E+00  | 0.000E+00  |             not used              | SOLUBK( 8)
     |                                            |            |            |                                   |
R016 | Distribution coefficients for Pu-240       |            |            |                                   |
R016 |   Contaminated zone (cm**3/g)              | 2.000E+03  | 2.000E+03  |                ---                | DCNUCC( 9)
R016 |   Unsaturated zone 1 (cm**3/g)             | 2.000E+03  | 2.000E+03  |                ---                | DCNUCU( 9,1)
R016 |   Saturated zone (cm**3/g)                 | 2.000E+03  | 2.000E+03  |                ---                | DCNUCS( 9)
R016 |   Leach rate (/yr)                         | 0.000E+00  | 0.000E+00  |             2.900E-05             | ALEACH( 9)
R016 |   Solubility constant                      | 0.000E+00  | 0.000E+00  |             not used              | SOLUBK( 9)
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                            Site-Specific Parameter Summary (continued)

     |                                       |  User     |           |       Used by RESRAD            | Parameter
Menu |               Parameter               |  Input    |  Default  | (If different from user input)  |   Name
-------------------------------------------------------------------------------------------------------------------
R016 | Distribution coefficients for Ra-226  |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)         | 7.000E+01 | 7.000E+01 |               ---               | DCNUCC(10)
R016 |   Unsaturated zone 1 (cm**3/g)        | 7.000E+01 | 7.000E+01 |               ---               | DCNUCU(10,1)
R016 |   Saturated zone (cm**3/g)            | 7.000E+01 | 7.000E+01 |               ---               | DCNUCS(10)
R016 |   Leach rate (/yr)                    | 0.000E+00 | 0.000E+00 |            8.266E-04            | ALEACH(10)
R016 |   Solubility constant                 | 0.000E+00 | 0.000E+00 |            not used             | SOLUBK(10)
     |                                       |           |           |                                 |
R016 | Distribution coefficients for Ra-228  |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)         | 7.000E+01 | 7.000E+01 |               ---               | DCNUCC(11)
R016 |   Unsaturated zone 1 (cm**3/g)        | 7.000E+01 | 7.000E+01 |               ---               | DCNUCU(11,1)
R016 |   Saturated zone (cm**3/g)            | 7.000E+01 | 7.000E+01 |               ---               | DCNUCS(11)
R016 |   Leach rate (/yr)                    | 0.000E+00 | 0.000E+00 |            8.266E-04            | ALEACH(11)
R016 |   Solubility constant                 | 0.000E+00 | 0.000E+00 |            not used             | SOLUBK(11)
     |                                       |           |           |                                 |
R016 | Distribution coefficients for Th-228  |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)         | 6.000E+04 | 6.000E+04 |               ---               | DCNUCC(12)
R016 |   Unsaturated zone 1 (cm**3/g)        | 6.000E+04 | 6.000E+04 |               ---               | DCNUCU(12,1)
R016 |   Saturated zone (cm**3/g)            | 6.000E+04 | 6.000E+04 |               ---               | DCNUCS(12)
R016 |   Leach rate (/yr)                    | 0.000E+00 | 0.000E+00 |            9.667E-07            | ALEACH(12)
R016 |   Solubility constant                 | 0.000E+00 | 0.000E+00 |            not used             | SOLUBK(12)
     |                                       |           |           |                                 |
R016 | Distribution coefficients for Th-230  |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)         | 6.000E+04 | 6.000E+04 |               ---               | DCNUCC(13)
R016 |   Unsaturated zone 1 (cm**3/g)        | 6.000E+04 | 6.000E+04 |               ---               | DCNUCU(13,1)
R016 |   Saturated zone (cm**3/g)            | 6.000E+04 | 6.000E+04 |               ---               | DCNUCS(13)
R016 |   Leach rate (/yr)                    | 0.000E+00 | 0.000E+00 |            9.667E-07            | ALEACH(13)
R016 |   Solubility constant                 | 0.000E+00 | 0.000E+00 |            not used             | SOLUBK(13)
     |                                       |           |           |                                 |
R016 | Distribution coefficients for Th-232  |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)         | 6.000E+04 | 6.000E+04 |               ---               | DCNUCC(14)
R016 |   Unsaturated zone 1 (cm**3/g)        | 6.000E+04 | 6.000E+04 |               ---               | DCNUCU(14,1)
R016 |   Saturated zone (cm**3/g)            | 6.000E+04 | 6.000E+04 |               ---               | DCNUCS(14)
R016 |   Leach rate (/yr)                    | 0.000E+00 | 0.000E+00 |            9.667E-07            | ALEACH(14)
R016 |   Solubility constant                 | 0.000E+00 | 0.000E+00 |            not used             | SOLUBK(14)
     |                                       |           |           |                                 |
R016 | Distribution coefficients for U-234   |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)         | 5.000E+01 | 5.000E+01 |               ---               | DCNUCC(15)
R016 |   Unsaturated zone 1 (cm**3/g)        | 5.000E+01 | 5.000E+01 |               ---               | DCNUCU(15,1)
R016 |   Saturated zone (cm**3/g)            | 5.000E+01 | 5.000E+01 |               ---               | DCNUCS(15)
R016 |   Leach rate (/yr)                    | 0.000E+00 | 0.000E+00 |            1.156E-03            | ALEACH(15)
R016 |   Solubility constant                 | 0.000E+00 | 0.000E+00 |            not used             | SOLUBK(15)
     |                                       |           |           |                                 |
R016 | Distribution coefficients for U-235   |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)         | 5.000E+01 | 5.000E+01 |               ---               | DCNUCC(16)
R016 |   Unsaturated zone 1 (cm**3/g)        | 5.000E+01 | 5.000E+01 |               ---               | DCNUCU(16,1)
R016 |   Saturated zone (cm**3/g)            | 5.000E+01 | 5.000E+01 |               ---               | DCNUCS(16)
R016 |   Leach rate (/yr)                    | 0.000E+00 | 0.000E+00 |            1.156E-03            | ALEACH(16)
R016 |   Solubility constant                 | 0.000E+00 | 0.000E+00 |            not used             | SOLUBK(16)
```

```
                                         Site-Specific Parameter Summary (continued)

     |                                                  |    User     |             |          Used by RESRAD              |  Parameter
Menu |                    Parameter                     |    Input    |   Default   |  (If different from user input)      |   Name
-----+--------------------------------------------------+-------------+-------------+--------------------------------------+----------------
R016 | Distribution coefficients for U-238              |             |             |                                      |
R016 |   Contaminated zone (cm**3/g)                    |  5.000E+01  |  5.000E+01  |                 ---                  | DCNUCC(18)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  5.000E+01  |  5.000E+01  |                 ---                  | DCNUCU(18,1)
R016 |   Saturated zone (cm**3/g)                       |  5.000E+01  |  5.000E+01  |                 ---                  | DCNUCS(18)
R016 |   Leach rate (/yr)                               |  0.000E+00  |  0.000E+00  |              1.156E-03               | ALEACH(18)
R016 |   Solubility constant                            |  0.000E+00  |  0.000E+00  |              not used                | SOLUBK(18)
     |                                                  |             |             |                                      |
R016 | Distribution coefficients for daughter U-236     |             |             |                                      |
R016 |   Contaminated zone (cm**3/g)                    |  5.000E+01  |  5.000E+01  |                 ---                  | DCNUCC(17)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  5.000E+01  |  5.000E+01  |                 ---                  | DCNUCU(17,1)
R016 |   Saturated zone (cm**3/g)                       |  5.000E+01  |  5.000E+01  |                 ---                  | DCNUCS(17)
R016 |   Leach rate (/yr)                               |  0.000E+00  |  0.000E+00  |              1.156E-03               | ALEACH(17)
R016 |   Solubility constant                            |  0.000E+00  |  0.000E+00  |              not used                | SOLUBK(17)
     |                                                  |             |             |                                      |
R017 | Inhalation rate (m**3/yr)                        |  5.000E+03  |  8.400E+03  |                 ---                  | INHALR
R017 | Mass loading for inhalation (g/m**3)             |  1.000E-04  |  1.000E-04  |                 ---                  | MLINH
R017 | Exposure duration                                |  2.500E+01  |  3.000E+01  |                 ---                  | ED
R017 | Shielding factor, inhalation                     |  4.000E-01  |  4.000E-01  |                 ---                  | SHF3
R017 | Shielding factor, external gamma                 |  7.000E-01  |  7.000E-01  |                 ---                  | SHF1
R017 | Fraction of time spent indoors                   |  4.000E-01  |  5.000E-01  |                 ---                  | FIND
R017 | Fraction of time spent outdoors (on site)        |  1.000E-01  |  2.500E-01  |                 ---                  | FOTD
R017 | Shape factor flag, external gamma                |  1.000E+00  |  1.000E+00  |      >0 shows circular AREA.         | FS
R017 | Radii of shape factor array (used if FS = -1):   |             |             |                                      |
R017 |   Outer annular radius (m), ring  1:             |  not used   |  5.000E+01  |                 ---                  | RAD SHAPE( 1)
R017 |   Outer annular radius (m), ring  2:             |  not used   |  7.071E+01  |                 ---                  | RAD SHAPE( 2)
R017 |   Outer annular radius (m), ring  3:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE( 3)
R017 |   Outer annular radius (m), ring  4:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE( 4)
R017 |   Outer annular radius (m), ring  5:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE( 5)
R017 |   Outer annular radius (m), ring  6:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE( 6)
R017 |   Outer annular radius (m), ring  7:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE( 7)
R017 |   Outer annular radius (m), ring  8:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE( 8)
R017 |   Outer annular radius (m), ring  9:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE( 9)
R017 |   Outer annular radius (m), ring 10:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE(10)
R017 |   Outer annular radius (m), ring 11:             |  not used   |  0.000E+00  |                 ---                  | RAD SHAPE(11)
R017 |   Outer annular radius (m), ring 12:             |  not used   |  0.000E+00  |                 ---                  | RAD_SHAPE(12)
     |                                                  |             |             |                                      |
R017 | Fractions of annular areas within AREA:          |             |             |                                      |
R017 |   Ring  1                                        |  not used   |  1.000E+00  |                 ---                  | FRACA( 1)
R017 |   Ring  2                                        |  not used   |  2.732E-01  |                 ---                  | FRACA( 2)
R017 |   Ring  3                                        |  not used   |  0.000E+00  |                 ---                  | FRACA( 3)
R017 |   Ring  4                                        |  not used   |  0.000E+00  |                 ---                  | FRACA( 4)
R017 |   Ring  5                                        |  not used   |  0.000E+00  |                 ---                  | FRACA( 5)
R017 |   Ring  6                                        |  not used   |  0.000E+00  |                 ---                  | FRACA( 6)
R017 |   Ring  7                                        |  not used   |  0.000E+00  |                 ---                  | FRACA( 7)
R017 |   Ring  8                                        |  not used   |  0.000E+00  |                 ---                  | FRACA( 8)
R017 |   Ring  9                                        |  not used   |  0.000E+00  |                 ---                  | FRACA( 9)
R017 |   Ring 10                                        |  not used   |  0.000E+00  |                 ---                  | FRACA(10)
R017 |   Ring 11                                        |  not used   |  0.000E+00  |                 ---                  | FRACA(11)
R017 |   Ring 12                                        |  not used   |  0.000E+00  |                 ---                  | FRACA(12)
     |                                                  |             |             |                                      |
R018 | Fruits, vegetables and grain consumption (kg/yr) |  not used   |  1.600E+02  |                 ---                  | DIET(1)
```

Site-Specific Parameter Summary (continued)

```
     |                                                      |   User    |            |             Used by RESRAD           |  Parameter
Menu |                    Parameter                         |   Input   |  Default   |  (If different from user input)     |    Name
-----+------------------------------------------------------+-----------+------------+-------------------------------------+------------
R018 | Leafy vegetable consumption (kg/yr)                  | not used  | 1.400E+01  |                 ---                 | DIET(2)
R018 | Milk consumption (L/yr)                              | not used  | 9.200E+01  |                 ---                 | DIET(3)
R018 | Meat and poultry consumption (kg/yr)                 | not used  | 6.300E+01  |                 ---                 | DIET(4)
R018 | Fish consumption (kg/yr)                             | not used  | 5.400E+00  |                 ---                 | DIET(5)
R018 | Other seafood consumption (kg/yr)                    | not used  | 9.000E-01  |                 ---                 | DIET(6)
R018 | Soil ingestion rate (g/yr)                           | 1.750E+01 | 3.650E+01  |                 ---                 | SOIL
R018 | Drinking water intake (L/yr)                         | 1.750E+02 | 5.100E+02  |                 ---                 | DWI
R018 | Contamination fraction of drinking water             | 1.000E+00 | 1.000E+00  |                 ---                 | FDW
R018 | Contamination fraction of household water            | not used  | 1.000E+00  |                 ---                 | FHHW
R018 | Contamination fraction of livestock water            | not used  | 1.000E+00  |                 ---                 | FLW
R018 | Contamination fraction of irrigation water           | not used  | 1.000E+00  |                 ---                 | FIRW
R018 | Contamination fraction of aquatic food               | not used  | 5.000E-01  |                 ---                 | FR9
R018 | Contamination fraction of plant food                 | not used  |-1          |                 ---                 | FPLANT
R018 | Contamination fraction of meat                       | not used  |-1          |                 ---                 | FMEAT
R018 | Contamination fraction of milk                       | not used  |-1          |                 ---                 | FMILK
     |                                                      |           |            |                                     |
R019 | Livestock fodder intake for meat (kg/day)            | not used  | 6.800E+01  |                 ---                 | LFI5
R019 | Livestock fodder intake for milk (kg/day)            | not used  | 5.500E+01  |                 ---                 | LFI6
R019 | Livestock water intake for meat (L/day)              | not used  | 5.000E+01  |                 ---                 | LWI5
R019 | Livestock water intake for milk (L/day)              | not used  | 1.600E+02  |                 ---                 | LWI6
R019 | Livestock soil intake (kg/day)                       | not used  | 5.000E-01  |                 ---                 | LSI
R019 | Mass loading for foliar deposition (g/m**3)          | not used  | 1.000E-04  |                 ---                 | MLFD
R019 | Depth of soil mixing layer (m)                       | 1.500E-01 | 1.500E-01  |                 ---                 | DM
R019 | Depth of roots (m)                                   | not used  | 9.000E-01  |                 ---                 | DROOT
R019 | Drinking water fraction from ground water            | 1.000E+00 | 1.000E+00  |                 ---                 | FGWDW
R019 | Household water fraction from ground water           | 1.000E+00 | 1.000E+00  |                 ---                 | FGWHH
R019 | Livestock water fraction from ground water           | not used  | 1.000E+00  |                 ---                 | FGWLW
R019 | Irrigation fraction from ground water                | not used  | 1.000E+00  |                 ---                 | FGWIR
     |                                                      |           |            |                                     |
R19B | Wet weight crop yield for Non-Leafy (kg/m**2)        | not used  | 7.000E-01  |                 ---                 | YV(1)
R19B | Wet weight crop yield for Leafy     (kg/m**2)        | not used  | 1.500E+00  |                 ---                 | YV(2)
R19B | Wet weight crop yield for Fodder    (kg/m**2)        | not used  | 1.100E+00  |                 ---                 | YV(3)
R19B | Growing Season for  Non-Leafy (years)                | not used  | 1.700E-01  |                 ---                 | TE(1)
R19B | Growing Season for  Leafy     (years)                | not used  | 2.500E-01  |                 ---                 | TE(2)
R19B | Growing Season for  Fodder    (years)                | not used  | 8.000E-02  |                 ---                 | TE(3)
R19B | Translocation Factor for  Non-Leafy                  | not used  | 1.000E-01  |                 ---                 | TIV(1)
R19B | Translocation Factor for  Leafy                      | not used  | 1.000E+00  |                 ---                 | TIV(2)
R19B | Translocation Factor for  Fodder                     | not used  | 1.000E+00  |                 ---                 | TIV(3)
R19B | Dry Foliar Interception Fraction for  Non-Leafy      | not used  | 2.500E-01  |                 ---                 | RDRY(1)
R19B | Dry Foliar Interception Fraction for  Leafy          | not used  | 2.500E-01  |                 ---                 | RDRY(2)
R19B | Dry Foliar Interception Fraction for  Fodder         | not used  | 2.500E-01  |                 ---                 | RDRY(3)
R19B | Wet Foliar Interception Fraction for  Non-Leafy      | not used  | 2.500E-01  |                 ---                 | RWET(1)
R19B | Wet Foliar Interception Fraction for  Leafy          | not used  | 2.500E-01  |                 ---                 | RWET(2)
R19B | Wet Foliar Interception Fraction for  Fodder         | not used  | 2.500E-01  |                 ---                 | RWET(3)
R19B | Weathering Removal Constant for Vegetation           | not used  | 2.000E+01  |                 ---                 | WLAM
     |                                                      |           |            |                                     |
C14  | C-12 concentration in water (g/cm**3)                | not used  | 2.000E-05  |                 ---                 | C12WTR
C14  | C-12 concentration in contaminated soil (g/g)        | not used  | 3.000E-02  |                 ---                 | C12CZ
C14  | Fraction of vegetation carbon from soil              | not used  | 2.000E-02  |                 ---                 | CSOIL
C14  | Fraction of vegetation carbon from air               | not used  | 9.800E-01  |                 ---                 | CAIR
C14  | C-14 evasion layer thickness in soil (m)             | not used  | 3.000E-01  |                 ---                 | DMC
```

```
                                        Site-Specific Parameter Summary (continued)

     |                                                    |   User    |           |         Used by RESRAD            | Parameter
Menu |                 Parameter                          |   Input   |  Default  | (If different from user input)    |   Name
-----+----------------------------------------------------+-----------+-----------+-----------------------------------+-----------
C14  | C-14 evasion flux rate from soil (1/sec)           | not used  | 7.000E-07 |               ---                 | EVSN
C14  | C-12 evasion flux rate from soil (1/sec)           | not used  | 1.000E-10 |               ---                 | REVSN
C14  | Fraction of grain in beef cattle feed              | not used  | 8.000E-01 |               ---                 | AVFG4
C14  | Fraction of grain in milk cow feed                 | not used  | 2.000E-01 |               ---                 | AVFG5
     |                                                    |           |           |                                   |
STOR | Storage times of contaminated foodstuffs (days):   |           |           |                                   |
STOR |   Fruits, non-leafy vegetables, and grain          | 1.400E+01 | 1.400E+01 |               ---                 | STOR_T(1)
STOR |   Leafy vegetables                                 | 1.000E+00 | 1.000E+00 |               ---                 | STOR_T(2)
STOR |   Milk                                             | 1.000E+00 | 1.000E+00 |               ---                 | STOR_T(3)
STOR |   Meat and poultry                                 | 2.000E+01 | 2.000E+01 |               ---                 | STOR_T(4)
STOR |   Fish                                             | 7.000E+00 | 7.000E+00 |               ---                 | STOR_T(5)
STOR |   Crustacea and mollusks                           | 7.000E+00 | 7.000E+00 |               ---                 | STOR_T(6)
STOR |   Well water                                       | 1.000E+00 | 1.000E+00 |               ---                 | STOR_T(7)
STOR |   Surface water                                    | 1.000E+00 | 1.000E+00 |               ---                 | STOR_T(8)
STOR |   Livestock fodder                                 | 4.500E+01 | 4.500E+01 |               ---                 | STOR_T(9)
     |                                                    |           |           |                                   |
R021 | Thickness of building foundation (m)               | not used  | 1.500E-01 |               ---                 | FLOOR
R021 | Bulk density of building foundation (g/cm**3)      | not used  | 2.400E+00 |               ---                 | DENSFL
R021 | Total porosity of the cover material               | not used  | 4.000E-01 |               ---                 | TPCV
R021 | Total porosity of the building foundation          | not used  | 1.000E-01 |               ---                 | TPFL
R021 | Volumetric water content of the cover material     | not used  | 5.000E-02 |               ---                 | PH2OCV
R021 | Volumetric water content of the foundation         | not used  | 3.000E-02 |               ---                 | PH2OFL
R021 | Diffusion coefficient for radon gas (m/sec):       |           |           |                                   |
R021 |   in cover material                                | not used  | 2.000E-06 |               ---                 | DIFCV
R021 |   in foundation material                           | not used  | 3.000E-07 |               ---                 | DIFFL
R021 |   in contaminated zone soil                        | not used  | 2.000E-06 |               ---                 | DIFCZ
R021 | Radon vertical dimension of mixing (m)             | not used  | 2.000E+00 |               ---                 | HMIX
R021 | Average building air exchange rate (1/hr)          | not used  | 5.000E-01 |               ---                 | REXG
R021 | Height of the building (room) (m)                  | not used  | 2.500E+00 |               ---                 | HRM
R021 | Building interior area factor                      | not used  | 0.000E+00 |               ---                 | FAI
R021 | Building depth below ground surface (m)            | not used  |-1.000E+00 |               ---                 | DMFL
R021 | Emanating power of Rn-222 gas                      | not used  | 2.500E-01 |               ---                 | EMANA(1)
R021 | Emanating power of Rn-220 gas                      | not used  | 1.500E-01 |               ---                 | EMANA(2)
=====================================================================================================================================


               Summary of Pathway Selections

            Pathway              |  User Selection
---------------------------------+-----------------
   1 -- external gamma           |     active
   2 -- inhalation (w/o radon)   |     active
   3 -- plant ingestion          |   suppressed
   4 -- meat ingestion           |   suppressed
   5 -- milk ingestion           |   suppressed
   6 -- aquatic foods            |   suppressed
   7 -- drinking water           |     active
   8 -- soil ingestion           |     active
   9 -- radon                    |   suppressed
   Find peak pathway doses       |   suppressed
=================================================
```

```
     Contaminated Zone Dimensions           Initial Soil Concentrations, pCi/g
     ____________________________           __________________________________

      Area:   3439.00 square meters                  Ac-227      1.000E+00
  Thickness:     2.00 meters                         Co-57       1.000E+00
Cover Depth:     0.00 meters                         Co-60       1.000E+00
                                                     Cs-137      1.000E+00
                                                     H-3         1.000E+00
                                                     Pa-231      1.000E+00
                                                     Pb-210      1.000E+00
                                                     Pu-239      1.000E+00
                                                     Pu-240      1.000E+00
                                                     Ra-226      1.000E+00
                                                     Ra-228      1.000E+00
                                                     Th-228      1.000E+00
                                                     Th-230      1.000E+00
                                                     Th-232      1.000E+00
                                                     U-234       1.000E+00
                                                     U-235       1.000E+00
                                                     U-238       1.000E+00

                                    Total Dose TDOSE(t), mrem/yr
                               Basic Radiation Dose Limit =  10 mrem/yr
              Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
              ___________________________________________________________________________
    t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
     TDOSE(t):  1.828E+01  1.744E+01  1.522E+01  1.364E+01  1.196E+01  1.150E+01  1.126E+01  1.109E+01
         M(t):  1.828E+00  1.744E+00  1.522E+00  1.364E+00  1.196E+00  1.150E+00  1.126E+00  1.109E+00

Maximum TDOSE(t):  1.828E+01 mrem/yr   at t = 0.000E+00 years
```

```
                   Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                   Water Independent Pathways (Inhalation excludes radon)

             Ground              Inhalation             Radon                Plant                Meat                 Milk                 Soil
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
Ac-227  7.062E-01 0.0386    1.152E-01 0.0063    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.295E-01 0.0071
Co-57   1.784E-01 0.0098    1.555E-07 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.033E-05 0.0000
Co-60   5.646E+00 0.3089    3.754E-06 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.354E-04 0.0000
Cs-137  1.180E+00 0.0646    5.468E-07 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.375E-04 0.0000
H-3     0.000E+00 0.0000    1.884E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.600E-07 0.0000
Pa-231  6.749E-02 0.0037    2.194E-02 0.0012    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.275E-02 0.0051
Pb-210  2.215E-03 0.0001    3.977E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.361E-02 0.0035
Pu-239  1.057E-04 0.0000    7.354E-03 0.0004    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.097E-02 0.0017
Pu-240  5.469E-05 0.0000    7.354E-03 0.0004    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.097E-02 0.0017
Ra-226  3.910E+00 0.2139    1.474E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.164E-02 0.0006
Ra-228  2.086E+00 0.1141    8.708E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.260E-02 0.0007
Th-228  3.570E+00 0.1953    5.914E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.070E-03 0.0004
Th-230  4.321E-04 0.0000    5.588E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.795E-03 0.0003
Th-232  1.869E-04 0.0000    2.811E-02 0.0015    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.389E-02 0.0013
U-234   1.449E-04 0.0000    2.263E-03 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.476E-03 0.0001
U-235   2.682E-01 0.0147    2.108E-03 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.336E-03 0.0001
U-238   4.791E-02 0.0026    2.023E-03 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.354E-03 0.0001
======= =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======
Total   1.766E+01 0.9664    1.987E-01 0.0109    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.157E-01 0.0227
```

```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                         Water Dependent Pathways

                 Water                Fish                Radon                Plant                Meat                 Milk             All Pathways*
Radio-    -------------------- -------------------- -------------------- -------------------- -------------------- -------------------- --------------------
Nuclide   mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------   ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------
Ac-227    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.509E-01 0.0520
Co-57     0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.784E-01 0.0098
Co-60     0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.646E+00 0.3089
Cs-137    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.180E+00 0.0646
H-3       0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.889E-04 0.0000
Pa-231    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.822E-01 0.0100
Pb-210    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.623E-02 0.0036
Pu-239    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.843E-02 0.0021
Pu-240    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.838E-02 0.0021
Ra-226    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.922E+00 0.2146
Ra-228    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.099E+00 0.1148
Th-228    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.583E+00 0.1960
Th-230    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.082E-02 0.0006
Th-232    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.219E-02 0.0029
U-234     0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.884E-03 0.0003
U-235     0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.726E-01 0.0149
U-238     0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.229E-02 0.0029
=======   ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total     0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.828E+01 1.0000

*Sum of all water independent and dependent pathways.
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RESRAD, Version 5.82     T½ Limit = 0.5 year       10/15/99  12:06    Page  16
Summary : SEAD-63 Park Worker - Site Specific Parameters        File: INDUS.RAD

                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                      Water Independent Pathways (Inhalation excludes radon)

              Ground             Inhalation             Radon                 Plant                  Meat                  Milk                  Soil
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227   6.821E-01  0.0391   1.113E-01  0.0064   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.251E-01  0.0072
Co-57    7.005E-02  0.0040   6.106E-08  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.055E-06  0.0000
Co-60    4.950E+00  0.2838   3.291E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.064E-04  0.0000
Cs-137   1.153E+00  0.0661   5.343E-07  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.275E-04  0.0000
H-3      0.000E+00  0.0000   5.414E-05  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.609E-07  0.0000
Pa-231   8.949E-02  0.0051   2.552E-02  0.0015   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   9.669E-02  0.0055
Pb-210   2.146E-03  0.0001   3.853E-04  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.163E-02  0.0035
Pu-239   1.057E-04  0.0000   7.354E-03  0.0004   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.097E-02  0.0018
Pu-240   5.468E-05  0.0000   7.353E-03  0.0004   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.097E-02  0.0018
Ra-226   3.906E+00  0.2239   1.594E-04  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.357E-02  0.0008
Ra-228   2.865E+00  0.1643   1.764E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.318E-02  0.0008
Th-228   2.485E+00  0.1425   4.117E-03  0.0002   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.921E-03  0.0003
Th-230   2.125E-03  0.0001   5.588E-03  0.0003   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.800E-03  0.0003
Th-232   3.035E-01  0.0174   2.823E-02  0.0016   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.545E-02  0.0015
U-234    1.447E-04  0.0000   2.260E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.473E-03  0.0001
U-235    2.679E-01  0.0154   2.107E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.336E-03  0.0001
U-238    4.785E-02  0.0027   2.020E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.351E-03  0.0001
=======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total    1.682E+01  0.9646   1.982E-01  0.0114   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.151E-01  0.0238
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              Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                          As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                          Water Dependent Pathways

               Water                Fish                Radon               Plant                Meat                Milk           All Pathways*
Radio-  ------------------- ------------------- ------------------- ------------------- ------------------- ------------------- -------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- -------
Ac-227  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 9.184E-01 0.0527
Co-57   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 7.005E-02 0.0040
Co-60   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.950E+00 0.2838
Cs-137  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.153E+00 0.0661
H-3     5.008E-03 0.0003 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 5.062E-03 0.0003
Pa-231  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.117E-01 0.0121
Pb-210  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 6.416E-02 0.0037
Pu-239  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.843E-02 0.0022
Pu-240  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.838E-02 0.0022
Ra-226  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.919E+00 0.2247
Ra-228  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.880E+00 0.1651
Th-228  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.494E+00 0.1430
Th-230  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.251E-02 0.0007
Th-232  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.572E-01 0.0205
U-234   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.878E-03 0.0003
U-235   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.723E-01 0.0156
U-238   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 5.223E-02 0.0030
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
Total   5.008E-03 0.0003 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.744E+01 1.0000

*Sum of all water independent and dependent pathways.
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                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                       Water Independent Pathways (Inhalation excludes radon)

             Ground            Inhalation            Radon               Plant               Meat                Milk                Soil
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------
Ac-227  5.937E-01 0.0390 9.684E-02 0.0064 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.089E-01 0.0072
Co-57   1.667E-03 0.0001 1.453E-09 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 9.648E-08 0.0000
Co-60   2.924E+00 0.1921 1.945E-06 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.219E-04 0.0000
Cs-137  1.051E+00 0.0690 4.870E-07 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.897E-04 0.0000
H-3     0.000E+00 0.0000 3.692E-07 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.098E-09 0.0000
Pa-231  1.700E-01 0.0112 3.860E-02 0.0025 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.111E-01 0.0073
Pb-210  1.891E-03 0.0001 3.395E-04 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 5.430E-02 0.0036
Pu-239  1.057E-04 0.0000 7.352E-03 0.0005 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.097E-02 0.0020
Pu-240  5.465E-05 0.0000 7.349E-03 0.0005 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.095E-02 0.0020
Ra-226  3.886E+00 0.2552 2.035E-04 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.068E-02 0.0014
Ra-228  3.186E+00 0.2092 3.442E-03 0.0002 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.093E-02 0.0007
Th-228  5.833E-01 0.0383 9.663E-04 0.0001 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.155E-03 0.0001
Th-230  8.876E-03 0.0006 5.588E-03 0.0004 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.830E-03 0.0003
Th-232  1.874E+00 0.1231 2.970E-02 0.0020 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.143E-02 0.0021
U-234   1.442E-04 0.0000 2.250E-03 0.0001 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.462E-03 0.0002
U-235   2.667E-01 0.0175 2.100E-03 0.0001 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.334E-03 0.0002
U-238   4.763E-02 0.0031 2.011E-03 0.0001 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.340E-03 0.0002
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
Total   1.459E+01 0.9586 1.967E-01 0.0129 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.128E-01 0.0271
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                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                     Water Dependent Pathways

              Water                Fish                Radon               Plant                Meat                Milk           All Pathways*
Radio-  ------------------- ------------------- ------------------- ------------------- ------------------- ------------------- -------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.994E-01 0.0525
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.667E-03 0.0001
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.925E+00 0.1921
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.051E+00 0.0690
H-3     2.043E-02 0.0013  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.043E-02 0.0013
Pa-231  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.196E-01 0.0210
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.653E-02 0.0037
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.842E-02 0.0025
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.836E-02 0.0025
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.907E+00 0.2566
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.200E+00 0.2102
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.854E-01 0.0384
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.929E-02 0.0013
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.935E+00 0.1271
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.856E-03 0.0003
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.711E-01 0.0178
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.198E-02 0.0034
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   2.043E-02 0.0013  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.522E+01 1.0000

*Sum of all water independent and dependent pathways.
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                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                          Water Independent Pathways (Inhalation excludes radon)

              Ground             Inhalation            Radon              Plant               Meat               Milk               Soil
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------
Ac-227   4.991E-01 0.0366  8.141E-02 0.0060  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.152E-02 0.0067
Co-57    1.557E-05 0.0000  1.358E-11 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.015E-10 0.0000
Co-60    1.515E+00 0.1111  1.007E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.315E-05 0.0000
Cs-137   9.359E-01 0.0686  4.338E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.470E-04 0.0000
H-3      0.000E+00 0.0000  7.228E-10 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.149E-12 0.0000
Pa-231   2.555E-01 0.0187  5.248E-02 0.0038  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.263E-01 0.0093
Pb-210   1.614E-03 0.0001  2.898E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.635E-02 0.0034
Pu-239   1.056E-04 0.0000  7.350E-03 0.0005  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.096E-02 0.0023
Pu-240   5.461E-05 0.0000  7.344E-03 0.0005  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.093E-02 0.0023
Ra-226   3.862E+00 0.2832  2.508E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.833E-02 0.0021
Ra-228   2.071E+00 0.1518  2.430E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.618E-03 0.0005
Th-228   9.530E-02 0.0070  1.579E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.888E-04 0.0000
Th-230   1.727E-02 0.0013  5.589E-03 0.0004  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.883E-03 0.0004
Th-232   3.466E+00 0.2541  3.150E-02 0.0023  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.666E-02 0.0027
U-234    1.440E-04 0.0000  2.237E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.448E-03 0.0002
U-235    2.652E-01 0.0194  2.092E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.333E-03 0.0002
U-238    4.736E-02 0.0035  2.000E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.327E-03 0.0002
=======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total    1.303E+01 0.9554  1.951E-01 0.0143  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.102E-01 0.0301
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                              Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                           As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                              Water Dependent Pathways

              Water                 Fish                 Radon                 Plant                 Meat                  Milk              All Pathways*
Radio-   ------------------   ------------------   ------------------   ------------------   ------------------   ------------------   ------------------
Nuclide   mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------
Ac-227   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.720E-01 0.0493
Co-57    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.558E-05 0.0000
Co-60    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.515E+00 0.1111
Cs-137   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.363E-01 0.0686
H-3      2.751E-03 0.0002   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.751E-03 0.0002
Pa-231   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.342E-01 0.0318
Pb-210   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.825E-02 0.0035
Pu-239   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.841E-02 0.0028
Pu-240   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.833E-02 0.0028
Ra-226   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.891E+00 0.2853
Ra-228   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.080E+00 0.1525
Th-228   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.565E-02 0.0070
Th-230   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.774E-02 0.0020
Th-232   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.534E+00 0.2591
U-234    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.829E-03 0.0004
U-235    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.696E-01 0.0198
U-238    0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   5.168E-02 0.0038
=======  ========== ======   ========== ======   ========== ======   ========== ======   ========== ======   ========== ======   ========== ======
Total    2.751E-03 0.0002   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.364E+01 1.0000

*Sum of all water independent and dependent pathways.
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                                 Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                               As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                  Water Independent Pathways (Inhalation excludes radon)

               Ground              Inhalation             Radon                 Plant                 Meat                  Milk                  Soil
Radio-   ------------------    ------------------    ------------------    ------------------    ------------------    ------------------    ------------------
Nuclide  mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------     ---------  ------
Ac-227   2.965E-01  0.0248     4.837E-02  0.0040     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     5.438E-02  0.0045
Co-57    1.271E-11  0.0000     1.108E-17  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     7.356E-16  0.0000
Co-60    2.105E-01  0.0176     1.400E-07  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     8.777E-06  0.0000
Cs-137   6.612E-01  0.0553     3.065E-07  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.452E-04  0.0000
H-3      0.000E+00  0.0000     5.381E-18  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.600E-20  0.0000
Pa-231   4.350E-01  0.0364     8.158E-02  0.0068     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.578E-01  0.0132
Pb-210   1.004E-03  0.0001     1.802E-04  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.883E-02  0.0024
Pu-239   1.056E-04  0.0000     7.343E-03  0.0006     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     3.093E-02  0.0026
Pu-240   5.450E-05  0.0000     7.329E-03  0.0006     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     3.087E-02  0.0026
Ra-226   3.790E+00  0.3170     3.526E-04  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     4.483E-02  0.0037
Ra-228   3.579E-01  0.0299     4.310E-04  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     1.116E-03  0.0001
Th-228   4.157E-04  0.0000     6.888E-07  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     8.234E-07  0.0000
Th-230   4.213E-02  0.0035     5.590E-03  0.0005     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     5.125E-03  0.0004
Th-232   5.261E+00  0.4400     3.364E-02  0.0028     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     4.231E-02  0.0035
U-234    1.455E-04  0.0000     2.199E-03  0.0002     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.407E-03  0.0002
U-235    2.607E-01  0.0218     2.078E-03  0.0002     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.338E-03  0.0002
U-238    4.654E-02  0.0039     1.965E-03  0.0002     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     2.287E-03  0.0002
=======  =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======     =========  ======
Total    1.136E+01  0.9503     1.911E-01  0.0160     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     0.000E+00  0.0000     4.035E-01  0.0337
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                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                  Water Dependent Pathways

              Water                Fish                Radon                Plant                Meat                 Milk             All Pathways*
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.993E-01 0.0334
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.271E-11 0.0000
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.105E-01 0.0176
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.615E-01 0.0553
H-3     6.713E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.713E-06 0.0000
Pa-231  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.744E-01 0.0564
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.001E-02 0.0025
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.838E-02 0.0032
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.825E-02 0.0032
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.835E+00 0.3207
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.595E-01 0.0301
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.172E-04 0.0000
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.284E-02 0.0044
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.337E+00 0.4463
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.751E-03 0.0004
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.651E-01 0.0222
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.080E-02 0.0042
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   6.713E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.196E+01 1.0000

*Sum of all water independent and dependent pathways.
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                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                       Water Independent Pathways (Inhalation excludes radon)

               Ground              Inhalation             Radon                Plant                Meat                 Milk                 Soil
Radio-    ------------------   ------------------   ------------------   ------------------   ------------------   ------------------   ------------------
Nuclide    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------   ---------   ------   ---------   ------   ---------   ------   ---------   ------   ---------   ------   ---------   ------   ---------   ------
Ac-227    1.762E-01   0.0153   2.874E-02   0.0025   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   3.231E-02   0.0028
Co-57     1.037E-17   0.0000   9.038E-24   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   6.002E-22   0.0000
Co-60     2.926E-02   0.0025   1.946E-08   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   1.220E-06   0.0000
Cs-137    4.671E-01   0.0406   2.165E-07   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   1.732E-04   0.0000
H-3       0.000E+00   0.0000   3.961E-26   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   1.178E-28   0.0000
Pa-231    5.367E-01   0.0467   9.798E-02   0.0085   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   1.751E-01   0.0152
Pb-210    6.243E-04   0.0001   1.121E-04   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   1.793E-02   0.0016
Pu-239    1.055E-04   0.0000   7.337E-03   0.0006   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   3.090E-02   0.0027
Pu-240    5.439E-05   0.0000   7.314E-03   0.0006   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   3.081E-02   0.0027
Ra-226    3.720E+00   0.3234   4.122E-04   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   5.458E-02   0.0047
Ra-228    5.806E-02   0.0050   6.995E-05   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   1.810E-04   0.0000
Th-228    1.814E-06   0.0000   3.005E-09   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   3.592E-09   0.0000
Th-230    6.652E-02   0.0058   5.591E-03   0.0005   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   5.450E-03   0.0005
Th-232    5.559E+00   0.4834   3.400E-02   0.0030   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   4.324E-02   0.0038
U-234     1.503E-04   0.0000   2.162E-03   0.0002   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   2.366E-03   0.0002
U-235     2.564E-01   0.0223   2.071E-03   0.0002   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   2.350E-03   0.0002
U-238     4.574E-02   0.0040   1.932E-03   0.0002   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   2.248E-03   0.0002
=======   =========   ======   =========   ======   =========   ======   =========   ======   =========   ======   =========   ======   =========   ======
Total     1.092E+01   0.9491   1.877E-01   0.0163   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   0.000E+00   0.0000   3.976E-01   0.0346
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              Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                          As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                           Water Dependent Pathways

             Water             Fish              Radon             Plant             Meat              Milk           All Pathways*
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide mrem/yr    fract. mrem/yr    fract. mrem/yr    fract. mrem/yr    fract. mrem/yr    fract. mrem/yr    fract. mrem/yr    fract.
------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- ------- --------- -------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.372E-01 0.0206
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.037E-17 0.0000
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.926E-02 0.0025
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.673E-01 0.0406
H-3     1.638E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.638E-08 0.0000
Pa-231  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.098E-01 0.0704
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.866E-02 0.0016
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.835E-02 0.0033
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.818E-02 0.0033
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.775E+00 0.3282
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.831E-02 0.0051
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.820E-06 0.0000
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.756E-02 0.0067
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.637E+00 0.4901
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.678E-03 0.0004
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.608E-01 0.0227
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.992E-02 0.0043
======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= ======= ========= =======
Total   1.638E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.150E+01 1.0000

*Sum of all water independent and dependent pathways.
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                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                     Water Independent Pathways (Inhalation excludes radon)

            Ground              Inhalation            Radon               Plant                Meat                Milk                 Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------  ---------- ------
Ac-227  1.047E-01 0.0093  1.707E-02 0.0015  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.919E-02 0.0017
Co-57   8.460E-24 0.0000  7.374E-30 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.897E-28 0.0000
Co-60   4.067E-03 0.0004  2.704E-09 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.695E-07 0.0000
Cs-137  3.300E-01 0.0293  1.530E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.224E-04 0.0000
H-3     0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
Pa-231  5.923E-01 0.0526  1.069E-01 0.0095  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.839E-01 0.0163
Pb-210  3.883E-04 0.0000  6.971E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.115E-02 0.0010
Pu-239  1.054E-04 0.0000  7.331E-03 0.0007  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.088E-02 0.0027
Pu-240  5.428E-05 0.0000  7.300E-03 0.0006  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.075E-02 0.0027
Ra-226  3.650E+00 0.3241  4.457E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.014E-02 0.0053
Ra-228  9.402E-03 0.0008  1.133E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.930E-05 0.0000
Th-228  7.911E-09 0.0000  1.311E-11 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.567E-11 0.0000
Th-230  9.045E-02 0.0080  5.593E-03 0.0005  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.823E-03 0.0005
Th-232  5.608E+00 0.4978  3.406E-02 0.0030  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.339E-02 0.0039
U-234   1.582E-04 0.0000  2.126E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.326E-03 0.0002
U-235   2.521E-01 0.0224  2.067E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.366E-03 0.0002
U-238   4.496E-02 0.0040  1.898E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.209E-03 0.0002
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.069E+01 0.9488  1.848E-01 0.0164  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.923E-01 0.0348
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                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                   As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                         Water Dependent Pathways

             Water                Fish                 Radon                Plant                Meat                 Milk             All Pathways*
Radio-  -------------------- -------------------- -------------------- -------------------- -------------------- -------------------- --------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------    ---------- ------
Ac-227  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.409E-01 0.0125
Co-57   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.460E-24 0.0000
Co-60   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.067E-03 0.0004
Cs-137  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.302E-01 0.0293
H-3     3.999E-11 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.999E-11 0.0000
Pa-231  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.831E-01 0.0784
Pb-210  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.161E-02 0.0010
Pu-239  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.831E-02 0.0034
Pu-240  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.810E-02 0.0034
Ra-226  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.711E+00 0.3295
Ra-228  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.442E-03 0.0008
Th-228  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.940E-09 0.0000
Th-230  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.019E-01 0.0090
Th-232  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.685E+00 0.5047
U-234   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.610E-03 0.0004
U-235   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.566E-01 0.0228
U-238   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.907E-02 0.0044
======= ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total   3.999E-11 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.126E+01 1.0000

*Sum of all water independent and dependent pathways.
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```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                     Water Independent Pathways (Inhalation excludes radon)

              Ground            Inhalation             Radon              Plant               Meat               Milk               Soil
Radio-   ----------------   ----------------   ----------------   ----------------   ----------------   ----------------   ----------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
-------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Ac-227   6.218E-02 0.0056   1.014E-02 0.0009   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.140E-02 0.0010
Co-57    6.902E-30 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000
Co-60    5.652E-04 0.0001   3.758E-10 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.356E-08 0.0000
Cs-137   2.332E-01 0.0210   1.081E-07 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.646E-05 0.0000
H-3      0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000
Pa-231   6.205E-01 0.0559   1.113E-01 0.0100   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.878E-01 0.0169
Pb-210   2.415E-04 0.0000   4.335E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.934E-03 0.0006
Pu-239   1.053E-04 0.0000   7.324E-03 0.0007   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.085E-02 0.0028
Pu-240   5.417E-05 0.0000   7.285E-03 0.0007   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.068E-02 0.0028
Ra-226   3.582E+00 0.3230   4.629E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.311E-02 0.0057
Ra-228   1.522E-03 0.0001   1.834E-06 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.745E-06 0.0000
Th-228   3.451E-11 0.0000   5.718E-14 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.835E-14 0.0000
Th-230   1.139E-01 0.0103   5.596E-03 0.0005   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.224E-03 0.0006
Th-232   5.615E+00 0.5063   3.407E-02 0.0031   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.342E-02 0.0039
U-234    1.692E-04 0.0000   2.090E-03 0.0002   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.287E-03 0.0002
U-235    2.480E-01 0.0224   2.066E-03 0.0002   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.384E-03 0.0002
U-238    4.418E-02 0.0040   1.866E-03 0.0002   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.171E-03 0.0002
=======  ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total    1.052E+01 0.9486   1.822E-01 0.0164   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.874E-01 0.0349
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                               Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                            As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                                 Water Dependent Pathways

               Water                Fish                 Radon                Plant                Meat                 Milk             All Pathways*
Radio-  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
Nuclide  mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
------- ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------   ---------- ------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.373E-02 0.0075
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.902E-30 0.0000
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.653E-04 0.0001
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.332E-01 0.0210
H-3     9.759E-14 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.759E-14 0.0000
Pa-231  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.196E-01 0.0829
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.219E-03 0.0007
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.828E-02 0.0035
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.802E-02 0.0034
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.646E+00 0.3287
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.529E-03 0.0001
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.464E-11 0.0000
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.258E-01 0.0113
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.693E+00 0.5133
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.546E-03 0.0004
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.525E-01 0.0228
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.822E-02 0.0043
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   9.759E-14 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.109E+01 1.0000

*Sum of all water independent and dependent pathways.
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                                Dose/Source Ratios Summed Over All Pathways
                      Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                                   DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)      (j)     Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
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Ac-227   Ac-227   1.000E+00    9.509E-01 9.184E-01 7.994E-01 6.720E-01 3.993E-01 2.372E-01 1.409E-01 8.373E-02

Co-57    Co-57    1.000E+00    1.784E-01 7.005E-02 1.667E-03 1.558E-05 1.271E-11 1.037E-17 8.460E-24 6.903E-30

Co-60    Co-60    1.000E+00    5.646E+00 4.950E+00 2.925E+00 1.515E+00 2.105E-01 2.926E-02 4.067E-03 5.653E-04

Cs-137   Cs-137   1.000E+00    1.180E+00 1.153E+00 1.051E+00 9.363E-01 6.615E-01 4.673E-01 3.302E-01 2.332E-01

H-3      H-3      1.000E+00    1.889E-04 5.062E-03 2.043E-02 2.751E-03 6.713E-06 1.638E-08 3.999E-11 9.759E-14

Pa-231   Pa-231   1.000E+00    1.822E-01 1.820E-01 1.811E-01 1.800E-01 1.769E-01 1.738E-01 1.708E-01 1.678E-01
Pa-231   Ac-227   1.000E+00    0.000E+00 2.973E-02 1.385E-01 2.542E-01 4.975E-01 6.360E-01 7.123E-01 7.518E-01
Pa-231   ∑DSR(j)               1.822E-01 2.117E-01 3.196E-01 4.342E-01 6.744E-01 8.098E-01 8.831E-01 9.196E-01

Pb-210   Pb-210   1.000E+00    6.623E-02 6.416E-02 5.653E-02 4.825E-02 3.001E-02 1.866E-02 1.161E-02 7.219E-03

Pu-239   Pu-239   1.000E+00    3.843E-02 3.843E-02 3.842E-02 3.841E-02 3.838E-02 3.835E-02 3.831E-02 3.828E-02
Pu-239   U-235    1.000E+00    0.000E+00 2.684E-10 1.339E-09 2.669E-09 6.612E-09 1.048E-08 1.429E-08 1.802E-08
Pu-239   Pa-231   1.000E+00    0.000E+00 1.897E-15 4.727E-14 1.883E-13 1.163E-12 2.942E-12 5.496E-12 8.798E-12
Pu-239   Ac-227   1.000E+00    0.000E+00 1.042E-16 1.255E-14 9.602E-14 1.320E-12 4.794E-12 1.114E-11 2.066E-11
Pu-239   ∑DSR(j)               3.843E-02 3.843E-02 3.842E-02 3.841E-02 3.838E-02 3.835E-02 3.831E-02 3.828E-02

Pu-240   Pu-240   1.000E+00    3.838E-02 3.838E-02 3.836E-02 3.833E-02 3.825E-02 3.818E-02 3.810E-02 3.802E-02
Pu-240   U-236    1.000E+00    0.000E+00 1.353E-10 6.749E-10 1.345E-09 3.331E-09 5.279E-09 7.189E-09 9.063E-09
Pu-240   Th-232   1.000E+00    0.000E+00 3.809E-20 9.507E-19 3.794E-18 2.356E-17 5.993E-17 1.126E-16 1.812E-16
Pu-240   Ra-228   1.000E+00    0.000E+00 5.973E-20 6.647E-18 4.649E-17 5.163E-16 1.613E-15 3.359E-15 5.750E-15
Pu-240   Th-228   1.000E+00    0.000E+00 8.656E-21 3.807E-18 4.158E-17 6.744E-16 2.344E-15 5.122E-15 9.002E-15
Pu-240   ∑DSR(j)               3.838E-02 3.838E-02 3.836E-02 3.833E-02 3.825E-02 3.818E-02 3.810E-02 3.802E-02

Ra-226   Ra-226   1.000E+00    3.922E+00 3.917E+00 3.898E+00 3.873E+00 3.801E+00 3.729E+00 3.660E+00 3.591E+00
Ra-226   Pb-210   1.000E+00    0.000E+00 2.025E-03 9.488E-03 1.753E-02 3.493E-02 4.530E-02 5.131E-02 5.461E-02
Ra-226   ∑DSR(j)               3.922E+00 3.919E+00 3.907E+00 3.891E+00 3.835E+00 3.775E+00 3.711E+00 3.646E+00

Ra-228   Ra-228   1.000E+00    2.099E+00 1.859E+00 1.144E+00 6.234E-01 1.010E-01 1.635E-02 2.647E-03 4.286E-04
Ra-228   Th-228   1.000E+00    0.000E+00 1.022E+00 2.056E+00 1.457E+00 2.585E-01 4.196E-02 6.795E-03 1.100E-03
Ra-228   ∑DSR(j)               2.099E+00 2.880E+00 3.200E+00 2.080E+00 3.595E-01 5.831E-02 9.442E-03 1.529E-03

Th-228   Th-228   1.000E+00    3.583E+00 2.494E+00 5.854E-01 9.565E-02 4.172E-04 1.820E-06 7.940E-09 3.464E-11

Th-230   Th-230   1.000E+00    1.082E-02 1.082E-02 1.081E-02 1.081E-02 1.081E-02 1.081E-02 1.081E-02 1.081E-02
Th-230   Ra-226   1.000E+00    0.000E+00 1.698E-03 8.469E-03 1.688E-02 4.181E-02 6.627E-02 9.026E-02 1.138E-01
Th-230   Pb-210   1.000E+00    0.000E+00 4.410E-07 1.056E-05 4.006E-05 2.152E-04 4.788E-04 7.944E-04 1.140E-03
Th-230   ∑DSR(j)               1.082E-02 1.251E-02 1.929E-02 2.774E-02 5.284E-02 7.756E-02 1.019E-01 1.258E-01

Th-232   Th-232   1.000E+00    5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.218E-02 5.218E-02
Th-232   Ra-228   1.000E+00    0.000E+00 2.382E-01 9.482E-01 1.465E+00 1.984E+00 2.068E+00 2.082E+00 2.084E+00
Th-232   Th-228   1.000E+00    0.000E+00 6.678E-02 9.347E-01 2.016E+00 3.301E+00 3.516E+00 3.551E+00 3.557E+00
Th-232   ∑DSR(j)               5.219E-02 3.572E-01 1.935E+00 3.534E+00 5.337E+00 5.637E+00 5.685E+00 5.693E+00
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                         Dose/Source Ratios Summed Over All Pathways
                Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                         DSR(j,t)   (mrem/yr)/(pCi/g)
 (i)      (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
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U-234    U-234    1.000E+00    4.884E-03 4.878E-03 4.856E-03 4.828E-03 4.744E-03 4.663E-03 4.582E-03 4.503E-03
U-234    Th-230   1.000E+00    0.000E+00 9.730E-08 4.854E-07 9.679E-07 2.399E-06 3.805E-06 5.186E-06 6.544E-06
U-234    Ra-226   1.000E+00    0.000E+00 7.642E-09 1.904E-07 7.586E-07 4.684E-06 1.185E-05 2.213E-05 3.542E-05
U-234    Pb-210   1.000E+00    0.000E+00 1.327E-12 1.603E-10 1.231E-09 1.708E-08 6.254E-08 1.463E-07 2.731E-07
U-234    ∑DSR(j)               4.884E-03 4.878E-03 4.856E-03 4.829E-03 4.751E-03 4.678E-03 4.610E-03 4.546E-03

U-235    U-235    1.000E+00    2.726E-01 2.723E-01 2.711E-01 2.695E-01 2.649E-01 2.603E-01 2.558E-01 2.514E-01
U-235    Pa-231   1.000E+00    0.000E+00 3.850E-06 1.916E-05 3.810E-05 9.360E-05 1.472E-04 1.988E-04 2.487E-04
U-235    Ac-227   1.000E+00    0.000E+00 3.163E-07 7.533E-06 2.839E-05 1.498E-04 3.277E-04 5.354E-04 7.573E-04
U-235    ∑DSR(j)               2.726E-01 2.723E-01 2.711E-01 2.696E-01 2.651E-01 2.608E-01 2.566E-01 2.525E-01

U-238    U-238    1.000E+00    5.229E-02 5.223E-02 5.198E-02 5.168E-02 5.080E-02 4.992E-02 4.906E-02 4.822E-02
U-238    U-234    1.000E+00    0.000E+00 1.383E-08 6.883E-08 1.369E-07 3.363E-07 5.288E-07 7.145E-07 8.938E-07
U-238    Th-230   1.000E+00    0.000E+00 1.379E-13 3.437E-12 1.369E-11 8.460E-11 2.141E-10 4.001E-10 6.406E-10
U-238    Ra-226   1.000E+00    0.000E+00 7.232E-15 8.993E-13 7.163E-12 1.104E-10 4.463E-10 1.145E-09 2.328E-09
U-238    Pb-210   1.000E+00    0.000E+00 1.107E-18 5.724E-16 8.848E-15 3.129E-13 1.866E-12 6.096E-12 1.468E-11
U-238    ∑DSR(j)               5.229E-02 5.223E-02 5.198E-02 5.168E-02 5.080E-02 4.992E-02 4.907E-02 4.822E-02
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*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.


                   Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                      Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)    t= 0.000E+00   1.000E+00   5.000E+00   1.000E+01   2.500E+01   4.000E+01   5.500E+01   7.000E+01
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Ac-227      1.052E+01   1.089E+01   1.251E+01   1.488E+01   2.505E+01   4.216E+01   7.096E+01   1.194E+02
Co-57       5.606E+01   1.427E+02   6.000E+03   6.421E+05   7.869E+11  *8.464E+15  *8.464E+15  *8.464E+15
Co-60       1.771E+00   2.020E+00   3.419E+00   6.601E+00   4.750E+01   3.417E+02   2.459E+03   1.769E+04
Cs-137      8.473E+00   8.671E+00   9.513E+00   1.068E+01   1.512E+01   2.140E+01   3.029E+01   4.287E+01
H-3         5.293E+04   1.976E+03   4.894E+02   3.635E+03   1.490E+06   6.103E+08   2.501E+11   1.025E+14
Pa-231      5.489E+01   4.724E+01   3.128E+01   2.303E+01   1.483E+01   1.235E+01   1.132E+01   1.087E+01
Pb-210      1.510E+02   1.559E+02   1.769E+02   2.072E+02   3.332E+02   5.358E+02   8.615E+02   1.385E+03
Pu-239      2.602E+02   2.602E+02   2.603E+02   2.603E+02   2.606E+02   2.608E+02   2.610E+02   2.612E+02
Pu-240      2.605E+02   2.606E+02   2.607E+02   2.609E+02   2.614E+02   2.619E+02   2.625E+02   2.630E+02
Ra-226      2.550E+00   2.552E+00   2.559E+00   2.570E+00   2.607E+00   2.649E+00   2.695E+00   2.743E+00
Ra-228      4.765E+00   3.472E+00   3.125E+00   4.807E+00   2.782E+01   1.715E+02   1.059E+03   6.540E+03
Th-228      2.791E+00   4.010E+00   1.708E+01   1.045E+02   2.397E+04   5.494E+06   1.259E+09   2.887E+11
Th-230      9.246E+02   7.991E+02   5.183E+02   3.605E+02   1.893E+02   1.289E+02   9.817E+01   7.952E+01
Th-232      1.916E+02   2.800E+01   5.168E+00   2.830E+00   1.874E+00   1.774E+00   1.759E+00   1.757E+00
U-234       2.048E+03   2.050E+03   2.059E+03   2.071E+03   2.105E+03   2.138E+03   2.169E+03   2.200E+03
U-235       3.668E+01   3.672E+01   3.689E+01   3.710E+01   3.772E+01   3.834E+01   3.897E+01   3.961E+01
U-238       1.913E+02   1.915E+02   1.924E+02   1.935E+02   1.969E+02   2.003E+02   2.038E+02   2.074E+02
=======     =========   =========   =========   =========   =========   =========   =========   =========
*At specific activity limit
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            Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
            and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
         at tmin = time of minimum single radionuclide soil guideline
     and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide  Initial          tmin         DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
  (i)     pCi/g          (years)                    (pCi/g)               (pCi/g)
_______ _________   ________________   _________   _________  _________  _________

Ac-227  1.000E+00      0.000E+00        9.509E-01  1.052E+01  9.509E-01  1.052E+01
Co-57   1.000E+00      0.000E+00        1.784E-01  5.606E+01  1.784E-01  5.606E+01
Co-60   1.000E+00      0.000E+00        5.646E+00  1.771E+00  5.646E+00  1.771E+00
Cs-137  1.000E+00      0.000E+00        1.180E+00  8.473E+00  1.180E+00  8.473E+00
H-3     1.000E+00    3.765 ± 0.008      3.348E-02  2.987E+02  1.889E-04  5.293E+04
Pa-231  1.000E+00      7.000E+01        9.196E-01  1.087E+01  1.822E-01  5.489E+01
Pb-210  1.000E+00      0.000E+00        6.623E-02  1.510E+02  6.623E-02  1.510E+02
Pu-239  1.000E+00      0.000E+00        3.843E-02  2.602E+02  3.843E-02  2.602E+02
Pu-240  1.000E+00      0.000E+00        3.838E-02  2.605E+02  3.838E-02  2.605E+02
Ra-226  1.000E+00      0.000E+00        3.922E+00  2.550E+00  3.922E+00  2.550E+00
Ra-228  1.000E+00    3.174 ± 0.006      3.387E+00  2.953E+00  2.099E+00  4.765E+00
Th-228  1.000E+00      0.000E+00        3.583E+00  2.791E+00  3.583E+00  2.791E+00
Th-230  1.000E+00      7.000E+01        1.258E-01  7.952E+01  1.082E-02  9.246E+02
Th-232  1.000E+00      7.000E+01        5.693E+00  1.757E+00  5.219E-02  1.916E+02
U-234   1.000E+00      0.000E+00        4.884E-03  2.048E+03  4.884E-03  2.048E+03
U-235   1.000E+00      0.000E+00        2.726E-01  3.668E+01  2.726E-01  3.668E+01
U-238   1.000E+00      0.000E+00        5.229E-02  1.913E+02  5.229E-02  1.913E+02
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                                  Individual Nuclide Dose Summed Over All Pathways
                                    Parent Nuclide and Branch Fraction Indicated

Nuclide Parent    BRF(i)                                                DOSE(j,t), mrem/yr
  (j)     (i)                    t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ ________ _________          _________ _________ _________ _________ _________ _________ _________ _________

Ac-227  Ac-227   1.000E+00          9.509E-01 9.184E-01 7.994E-01 6.720E-01 3.993E-01 2.372E-01 1.409E-01 8.373E-02
Ac-227  Pa-231   1.000E+00          0.000E+00 2.973E-02 1.385E-01 2.542E-01 4.975E-01 6.360E-01 7.123E-01 7.518E-01
Ac-227  Pu-239   1.000E+00          0.000E+00 1.042E-16 1.255E-14 9.602E-14 1.320E-12 4.794E-12 1.114E-11 2.066E-11
Ac-227  U-235    1.000E+00          0.000E+00 3.163E-07 7.533E-06 2.839E-05 1.498E-04 3.277E-04 5.354E-04 7.573E-04
Ac-227  ∑DOSE(j):                   9.509E-01 9.482E-01 9.379E-01 9.262E-01 8.969E-01 8.735E-01 8.538E-01 8.363E-01

Co-57   Co-57    1.000E+00          1.784E-01 7.005E-02 1.667E-03 1.558E-05 1.271E-11 1.037E-17 8.460E-24 6.902E-30

Co-60   Co-60    1.000E+00          5.646E+00 4.950E+00 2.925E+00 1.515E+00 2.105E-01 2.926E-02 4.067E-03 5.653E-04

Cs-137  Cs-137   1.000E+00          1.180E+00 1.153E+00 1.051E+00 9.363E-01 6.615E-01 4.673E-01 3.302E-01 2.332E-01

H-3     H-3      1.000E+00          1.889E-04 5.062E-03 2.043E-02 2.751E-03 6.713E-06 1.638E-08 3.999E-11 9.759E-14

Pa-231  Pa-231   1.000E+00          1.822E-01 1.820E-01 1.811E-01 1.800E-01 1.769E-01 1.738E-01 1.708E-01 1.678E-01
Pa-231  Pu-239   1.000E+00          0.000E+00 1.897E-15 4.727E-14 1.883E-13 1.163E-12 2.942E-12 5.496E-12 8.798E-12
Pa-231  U-235    1.000E+00          0.000E+00 3.850E-06 1.916E-05 3.810E-05 9.360E-05 1.472E-04 1.988E-04 2.487E-04
Pa-231  ∑DOSE(j):                   1.822E-01 1.820E-01 1.811E-01 1.801E-01 1.770E-01 1.739E-01 1.710E-01 1.680E-01

Pb-210  Pb-210   1.000E+00          6.623E-02 6.416E-02 5.653E-02 4.825E-02 3.001E-02 1.866E-02 1.161E-02 7.219E-03
Pb-210  Ra-226   1.000E+00          0.000E+00 2.025E-03 9.488E-03 1.753E-02 3.493E-02 4.530E-02 5.131E-02 5.461E-02
Pb-210  Th-230   1.000E+00          0.000E+00 4.410E-07 1.056E-05 4.006E-05 2.152E-04 4.788E-04 7.944E-04 1.140E-03
Pb-210  U-234    1.000E+00          0.000E+00 1.327E-12 1.603E-10 1.231E-09 1.708E-08 6.254E-08 1.463E-07 2.731E-07
Pb-210  U-238    1.000E+00          0.000E+00 1.107E-18 5.724E-16 8.848E-15 3.129E-13 1.866E-12 6.096E-12 1.468E-11
Pb-210  ∑DOSE(j):                   6.623E-02 6.619E-02 6.603E-02 6.582E-02 6.515E-02 6.444E-02 6.371E-02 6.297E-02

Pu-239  Pu-239   1.000E+00          3.843E-02 3.843E-02 3.842E-02 3.841E-02 3.838E-02 3.835E-02 3.831E-02 3.828E-02

U-235   Pu-239   1.000E+00          0.000E+00 2.684E-10 1.339E-09 2.669E-09 6.612E-09 1.048E-08 1.429E-08 1.802E-08
U-235   U-235    1.000E+00          2.726E-01 2.723E-01 2.711E-01 2.695E-01 2.649E-01 2.603E-01 2.558E-01 2.514E-01
U-235   ∑DOSE(j):                   2.726E-01 2.723E-01 2.711E-01 2.695E-01 2.649E-01 2.603E-01 2.558E-01 2.514E-01

Pu-240  Pu-240   1.000E+00          3.838E-02 3.838E-02 3.836E-02 3.833E-02 3.825E-02 3.818E-02 3.810E-02 3.802E-02

U-236   Pu-240   1.000E+00          0.000E+00 1.353E-10 6.749E-10 1.345E-09 3.331E-09 5.279E-09 7.189E-09 9.063E-09

Th-232  Pu-240   1.000E+00          0.000E+00 3.809E-20 9.507E-19 3.794E-18 2.356E-17 5.993E-17 1.126E-16 1.812E-16
Th-232  Th-232   1.000E+00          5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.218E-02 5.218E-02
Th-232  ∑DOSE(j):                   5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.219E-02 5.218E-02 5.218E-02

Ra-228  Pu-240   1.000E+00          0.000E+00 5.973E-20 6.647E-18 4.649E-17 5.163E-16 1.613E-15 3.359E-15 5.750E-15
Ra-228  Ra-228   1.000E+00          2.099E+00 1.859E+00 1.144E+00 6.234E-01 1.010E-01 1.635E-02 2.647E-03 4.286E-04
Ra-228  Th-232   1.000E+00          0.000E+00 2.382E-01 9.482E-01 1.465E+00 1.984E+00 2.068E+00 2.082E+00 2.084E+00
Ra-228  ∑DOSE(j):                   2.099E+00 2.097E+00 2.092E+00 2.088E+00 2.085E+00 2.084E+00 2.084E+00 2.084E+00

Th-228  Pu-240   1.000E+00          0.000E+00 8.656E-21 3.807E-18 4.158E-17 6.744E-16 2.344E-15 5.122E-15 9.002E-15
Th-228  Ra-228   1.000E+00          0.000E+00 1.022E+00 2.056E+00 1.457E+00 2.585E-01 4.196E-02 6.795E-03 1.100E-03
Th-228  Th-228   1.000E+00          3.583E+00 2.494E+00 5.854E-01 9.565E-02 4.172E-04 1.820E-06 7.940E-09 3.464E-11
Th-228  Th-232   1.000E+00          0.000E+00 6.678E-02 9.347E-01 2.016E+00 3.301E+00 3.516E+00 3.551E+00 3.557E+00
Th-228  ∑DOSE(j):                   3.583E+00 3.582E+00 3.576E+00 3.569E+00 3.560E+00 3.558E+00 3.558E+00 3.558E+00
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                                  Individual Nuclide Dose Summed Over All Pathways
                                    Parent Nuclide and Branch Fraction Indicated

Nuclide Parent   BRF(i)                                    DOSE(j,t), mrem/yr
  (j)     (i)               t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
------- ------- ---------      --------- --------- --------- --------- --------- --------- --------- ---------
Ra-226  Ra-226  1.000E+00      3.922E+00 3.917E+00 3.898E+00 3.873E+00 3.801E+00 3.729E+00 3.660E+00 3.591E+00
Ra-226  Th-230  1.000E+00      0.000E+00 1.698E-03 8.469E-03 1.688E-02 4.181E-02 6.627E-02 9.026E-02 1.138E-01
Ra-226  U-234   1.000E+00      0.000E+00 7.642E-09 1.904E-07 7.586E-07 4.684E-06 1.185E-05 2.213E-05 3.542E-05
Ra-226  U-238   1.000E+00      0.000E+00 7.232E-15 8.993E-13 7.163E-12 1.104E-10 4.463E-10 1.145E-09 2.328E-09
Ra-226  ∑DOSE(j):              3.922E+00 3.919E+00 3.906E+00 3.890E+00 3.842E+00 3.796E+00 3.750E+00 3.705E+00

Th-230  Th-230  1.000E+00      1.082E-02 1.082E-02 1.081E-02 1.081E-02 1.081E-02 1.081E-02 1.081E-02 1.081E-02
Th-230  U-234   1.000E+00      0.000E+00 9.730E-08 4.854E-07 9.679E-07 2.399E-06 3.805E-06 5.186E-06 6.544E-06
Th-230  U-238   1.000E+00      0.000E+00 1.379E-13 3.437E-12 1.369E-11 8.460E-11 2.141E-10 4.001E-10 6.406E-10
Th-230  ∑DOSE(j):              1.082E-02 1.082E-02 1.082E-02 1.082E-02 1.082E-02 1.081E-02 1.081E-02 1.081E-02

U-234   U-234   1.000E+00      4.884E-03 4.878E-03 4.856E-03 4.828E-03 4.744E-03 4.663E-03 4.582E-03 4.503E-03
U-234   U-238   1.000E+00      0.000E+00 1.383E-08 6.883E-08 1.369E-07 3.363E-07 5.288E-07 7.145E-07 8.938E-07
U-234   ∑DOSE(j):              4.884E-03 4.878E-03 4.856E-03 4.828E-03 4.745E-03 4.663E-03 4.583E-03 4.504E-03

U-238   U-238   1.000E+00      5.229E-02 5.223E-02 5.198E-02 5.168E-02 5.080E-02 4.992E-02 4.906E-02 4.822E-02
======= ======= =========      ========= ========= ========= ========= ========= ========= ========= =========
BRF(i) is the branch fraction of the parent nuclide.
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                                   Individual Nuclide Soil Concentration
                                Parent Nuclide and Branch Fraction Indicated

uclide  Parent     BRF(i)                                           S(j,t), pCi/g
 (j)     (i)                   t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
______  ______  _________          _________ _________ _________ _________ _________ _________ _________ _________

c-227   Ac-227  1.000E+00          1.000E+00 9.659E-01 8.407E-01 7.067E-01 4.199E-01 2.495E-01 1.482E-01 8.806E-02
c-227   Pa-231  1.000E+00          0.000E+00 3.127E-02 1.457E-01 2.673E-01 5.232E-01 6.689E-01 7.491E-01 7.907E-01
c-227   Pu-239  1.000E+00          0.000E+00 1.095E-16 1.320E-14 1.010E-13 1.388E-12 5.041E-12 1.171E-11 2.173E-11
c-227   U-235   1.000E+00          0.000E+00 3.327E-07 7.922E-06 2.986E-05 1.575E-04 3.446E-04 5.631E-04 7.964E-04
c-227   ∑S(j):                     1.000E+00 9.972E-01 9.864E-01 9.741E-01 9.432E-01 9.187E-01 8.979E-01 8.795E-01

o-57    Co-57   1.000E+00          1.000E+00 3.927E-01 9.344E-03 8.732E-05 7.124E-11 5.813E-17 4.743E-23 3.870E-29

o-60    Co-60   1.000E+00          1.000E+00 8.767E-01 5.180E-01 2.683E-01 3.729E-02 5.183E-03 7.203E-04 1.001E-04

s-137   Cs-137  1.000E+00          1.000E+00 9.771E-01 8.906E-01 7.932E-01 5.604E-01 3.959E-01 2.797E-01 1.976E-01

-3      H-3     1.000E+00          1.000E+00 2.874E-01 1.960E-03 3.837E-06 2.857E-14 2.103E-22 1.530E-30 1.101E-38

a-231   Pa-231  1.000E+00          1.000E+00 9.988E-01 9.941E-01 9.883E-01 9.710E-01 9.540E-01 9.373E-01 9.209E-01
a-231   Pu-239  1.000E+00          0.000E+00 1.041E-14 2.594E-13 1.034E-12 6.384E-12 1.615E-11 3.017E-11 4.829E-11
a-231   U-235   1.000E+00          0.000E+00 2.113E-05 1.052E-04 2.091E-04 5.138E-04 8.077E-04 1.091E-03 1.365E-03
a-231   ∑S(j):                     1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01

b-210   Pb-210  1.000E+00          1.000E+00 9.688E-01 8.536E-01 7.286E-01 4.531E-01 2.818E-01 1.753E-01 1.090E-01
b-210   Ra-226  1.000E+00          0.000E+00 3.058E-02 1.433E-01 2.647E-01 5.274E-01 6.840E-01 7.748E-01 8.246E-01
b-210   Th-230  1.000E+00          0.000E+00 6.659E-06 1.594E-04 6.049E-04 3.250E-03 7.230E-03 1.200E-02 1.721E-02
b-210   U-234   1.000E+00          0.000E+00 2.003E-11 2.421E-09 1.858E-08 2.578E-07 9.443E-07 2.209E-06 4.123E-06
b-210   U-238   1.000E+00          0.000E+00 1.671E-17 8.644E-15 1.336E-13 4.725E-12 2.818E-11 9.206E-11 2.217E-10
b-210   ∑S(j):                     1.000E+00 9.994E-01 9.970E-01 9.939E-01 9.838E-01 9.731E-01 9.620E-01 9.509E-01

Pu-239  Pu-239  1.000E+00          1.000E+00 9.999E-01 9.997E-01 9.994E-01 9.986E-01 9.977E-01 9.968E-01 9.960E-01

J-235   Pu-239  1.000E+00          0.000E+00 9.843E-10 4.909E-09 9.789E-09 2.425E-08 3.845E-08 5.240E-08 6.609E-08
J-235   U-235   1.000E+00          1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01
J-235   ∑S(j):                     1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01

Pu-240  Pu-240  1.000E+00          1.000E+00 9.999E-01 9.993E-01 9.987E-01 9.966E-01 9.946E-01 9.926E-01 9.906E-01

U-236   Pu-240  1.000E+00          0.000E+00 2.958E-08 1.475E-07 2.941E-07 7.282E-07 1.154E-06 1.572E-06 1.981E-06

Th-232  Pu-240  1.000E+00          0.000E+00 7.299E-19 1.822E-17 7.271E-17 4.515E-16 1.148E-15 2.157E-15 3.472E-15
Th-232  Th-232  1.000E+00          1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01
Th-232  ∑S(j):                     1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01

Ra-228  Pu-240  1.000E+00          0.000E+00 2.846E-20 3.167E-18 2.215E-17 2.460E-16 7.685E-16 1.601E-15 2.740E-15
Ra-228  Ra-228  1.000E+00          1.000E+00 8.857E-01 5.451E-01 2.971E-01 4.811E-02 7.790E-03 1.261E-03 2.042E-04
Ra-228  Th-232  1.000E+00          0.000E+00 1.135E-01 4.518E-01 6.981E-01 9.454E-01 9.854E-01 9.919E-01 9.929E-01
Ra-228  ∑S(j):                     1.000E+00 9.992E-01 9.969E-01 9.952E-01 9.935E-01 9.932E-01 9.932E-01 9.931E-01

Th-228  Pu-240  1.000E+00          0.000E+00 2.416E-21 1.063E-18 1.161E-17 1.882E-16 6.543E-16 1.430E-15 2.513E-15
Th-228  Ra-228  1.000E+00          0.000E+00 2.852E-01 5.739E-01 4.066E-01 7.216E-02 1.171E-02 1.897E-03 3.071E-04
Th-228  Th-228  1.000E+00          1.000E+00 6.961E-01 1.634E-01 2.670E-02 1.165E-04 5.080E-07 2.216E-09 9.668E-12
Th-228  Th-232  1.000E+00          0.000E+00 1.864E-02 2.609E-01 5.628E-01 9.214E-01 9.815E-01 9.913E-01 9.928E-01
Th-228  ∑S(j):                     1.000E+00 9.999E-01 9.982E-01 9.961E-01 9.937E-01 9.932E-01 9.932E-01 9.931E-01
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                                  Individual Nuclide Soil Concentration
                               Parent Nuclide and Branch Fraction Indicated

Nuclide  Parent    BRF(i)                                          S(j,t), pCi/q
  (j)      (i)                 t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______  _______  _________       _________ _________ _________ _________ _________ _________ _________ _________
Ra-226   Ra-226   1.000E+00       1.000E+00 9.987E-01 9.937E-01 9.875E-01 9.690E-01 9.509E-01 9.331E-01 9.156E-01
Ra-226   Th-230   1.000E+00       0.000E+00 4.329E-04 2.159E-03 4.305E-03 1.066E-02 1.690E-02 2.301E-02 2.902E-02
Ra-226   U-234    1.000E+00       0.000E+00 1.948E-09 4.855E-08 1.934E-07 1.194E-06 3.021E-06 5.642E-06 9.030E-06
Ra-226   U-238    1.000E+00       0.000E+00 1.844E-15 2.293E-13 1.826E-12 2.815E-11 1.138E-10 2.918E-10 5.937E-10
Ra-226   ∑S(j):                   1.000E+00 9.992E-01 9.959E-01 9.918E-01 9.797E-01 9.678E-01 9.561E-01 9.446E-01

Th-230   Th-230   1.000E+00       1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.998E-01 9.996E-01 9.995E-01 9.993E-01
Th-230   U-234    1.000E+00       0.000E+00 8.997E-06 4.488E-05 8.950E-05 2.218E-04 3.518E-04 4.795E-04 6.050E-04
Th-230   U-238    1.000E+00       0.000E+00 1.275E-11 3.178E-10 1.266E-09 7.822E-09 1.979E-08 3.699E-08 5.923E-08
Th-230   ∑S(j):                   1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01

U-234    U-234    1.000E+00       1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.714E-01 9.547E-01 9.382E-01 9.221E-01
U-234    U-238    1.000E+00       0.000E+00 2.832E-06 1.409E-05 2.802E-05 6.885E-05 1.083E-04 1.463E-04 1.830E-04
U-234    ∑S(j):                   1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01

U-238    U-238    1.000E+00       1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01
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BRF(i) is the branch fraction of the parent nuclide.
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RESRAD OUTPUT FOR RECREATIONAL CHILD – SOIL SUPPORT FOR DERIVATION OF CLEAN UP GOAL

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                          Table of Contents
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   Part I: Mixture Sums and Single Radionuclide Guidelines
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                        Dose Conversion Factor (and Related) Parameter Summary
                                          File: DOSFAC.BIN

     |                                                       |  Current   |            | Parameter
Menu |                      Parameter                        |   Value    |  Default   |   Name
-----+-------------------------------------------------------+------------+------------+------------
B-1  | Dose conversion factors for inhalation, mrem/pCi:     |            |            |
B-1  | Ac-227+D                                              | 6.720E+00  | 6.720E+00  | DCF2( 1)
B-1  | Co-57                                                 | 9.070E-06  | 9.070E-06  | DCF2( 2)
B-1  | Co-60                                                 | 2.190E-04  | 2.190E-04  | DCF2( 3)
B-1  | Cs-137+D                                              | 3.190E-05  | 3.190E-05  | DCF2( 4)
B-1  | H-3                                                   | 6.400E-08  | 6.400E-08  | DCF2( 5)
B-1  | Pa-231                                                | 1.280E+00  | 1.280E+00  | DCF2( 6)
B-1  | Pb-210+D                                              | 2.320E-02  | 2.320E-02  | DCF2( 7)
B-1  | Pu-239                                                | 4.290E-01  | 4.290E-01  | DCF2( 8)
B-1  | Pu-240                                                | 4.290E-01  | 4.290E-01  | DCF2( 9)
B-1  | Ra-226+D                                              | 8.600E-03  | 8.600E-03  | DCF2(10)
B-1  | Ra-228+D                                              | 5.080E-03  | 5.080E-03  | DCF2(11)
B-1  | Th-228+D                                              | 3.450E-01  | 3.450E-01  | DCF2(12)
B-1  | Th-230                                                | 3.260E-01  | 3.260E-01  | DCF2(13)
B-1  | Th-232                                                | 1.640E+00  | 1.640E+00  | DCF2(14)
B-1  | U-234                                                 | 1.320E-01  | 1.320E-01  | DCF2(15)
B-1  | U-235+D                                               | 1.230E-01  | 1.230E-01  | DCF2(16)
B-1  | U-236                                                 | 1.250E-01  | 1.250E-01  | DCF2(17)
B-1  | U-238+D                                               | 1.180E-01  | 1.180E-01  | DCF2(18)
     |                                                       |            |            |
D-1  | Dose conversion factors for ingestion, mrem/pCi:      |            |            |
D-1  | Ac-227+D                                              | 1.480E-02  | 1.480E-02  | DCF3( 1)
D-1  | Co-57                                                 | 1.180E-06  | 1.180E-06  | DCF3( 2)
D-1  | Co-60                                                 | 2.690E-05  | 2.690E-05  | DCF3( 3)
D-1  | Cs-137+D                                              | 5.000E-05  | 5.000E-05  | DCF3( 4)
D-1  | H-3                                                   | 6.400E-08  | 6.400E-08  | DCF3( 5)
D-1  | Pa-231                                                | 1.060E-02  | 1.060E-02  | DCF3( 6)
D-1  | Pb-210+D                                              | 7.270E-03  | 7.270E-03  | DCF3( 7)
D-1  | Pu-239                                                | 3.540E-03  | 3.540E-03  | DCF3( 8)
D-1  | Pu-240                                                | 3.540E-03  | 3.540E-03  | DCF3( 9)
D-1  | Ra-226+D                                              | 1.330E-03  | 1.330E-03  | DCF3(10)
D-1  | Ra-228+D                                              | 1.440E-03  | 1.440E-03  | DCF3(11)
D-1  | Th-228+D                                              | 8.080E-04  | 8.080E-04  | DCF3(12)
D-1  | Th-230                                                | 5.480E-04  | 5.480E-04  | DCF3(13)
D-1  | Th-232                                                | 2.730E-03  | 2.730E-03  | DCF3(14)
D-1  | U-234                                                 | 2.830E-04  | 2.830E-04  | DCF3(15)
D-1  | U-235+D                                               | 2.670E-04  | 2.670E-04  | DCF3(16)
D-1  | U-236                                                 | 2.690E-04  | 2.690E-04  | DCF3(17)
D-1  | U-238+D                                               | 2.690E-04  | 2.690E-04  | DCF3(18)
     |                                                       |            |            |
D-34 | Food transfer factors:                                |            |            |
D-34 | Ac-227+D , plant/soil concentration ratio, dimensionless | 2.500E-03  | 2.500E-03  | RTF( 1,1)
D-34 | Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-05  | 2.000E-05  | RTF( 1,2)
D-34 | Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 2.000E-05  | 2.000E-05  | RTF( 1,3)
D-34 |                                                       |            |            |
D-34 | Co-57    , plant/soil concentration ratio, dimensionless | 8.000E-02  | 8.000E-02  | RTF( 2,1)
D-34 | Co-57    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-02  | 2.000E-02  | RTF( 2,2)
D-34 | Co-57    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 2.000E-03  | 2.000E-03  | RTF( 2,3)
D-34 |                                                       |            |            |
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                   Dose Conversion Factor (and Related) Parameter Summary (continued)
                                         File: DOSFAC.BIN

    |                                                        | Current   |           | Parameter
enu |                      Parameter                         |  Value    |  Default  |   Name
----+--------------------------------------------------------+-----------+-----------+-------------
-34 | Co-60    , plant/soil concentration ratio, dimensionless | 8.000E-02 | 8.000E-02 | RTF( 3,1)
-34 | Co-60    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-02 | 2.000E-02 | RTF( 3,2)
-34 | Co-60    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 2.000E-03 | 2.000E-03 | RTF( 3,3)
-34 |                                                        |           |           |
-34 | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 4,1)
-34 | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 4,2)
-34 | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 8.000E-03 | 8.000E-03 | RTF( 4,3)
-34 |                                                        |           |           |
-34 | H-3      , plant/soil concentration ratio, dimensionless | 4.800E+00 | 4.800E+00 | RTF( 5,1)
-34 | H-3      , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.200E-02 | 1.200E-02 | RTF( 5,2)
-34 | H-3      , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-02 | 1.000E-02 | RTF( 5,3)
-34 |                                                        |           |           |
-34 | Pa-231   , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 6,1)
-34 | Pa-231   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 6,2)
-34 | Pa-231   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF( 6,3)
-34 |                                                        |           |           |
-34 | Pb-210+D , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 7,1)
-34 | Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04 | 8.000E-04 | RTF( 7,2)
-34 | Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 3.000E-04 | 3.000E-04 | RTF( 7,3)
-34 |                                                        |           |           |
-34 | Pu-239   , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 8,1)
-34 | Pu-239   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 8,2)
-34 | Pu-239   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-06 | 1.000E-06 | RTF( 8,3)
-34 |                                                        |           |           |
-34 | Pu-240   , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 9,1)
-34 | Pu-240   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 9,2)
-34 | Pu-240   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-06 | 1.000E-06 | RTF( 9,3)
-34 |                                                        |           |           |
-34 | Ra-226+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF(10,1)
-34 | Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF(10,2)
-34 | Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03 | 1.000E-03 | RTF(10,3)
-34 |                                                        |           |           |
-34 | Ra-228+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF(11,1)
-34 | Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF(11,2)
-34 | Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 1.000E-03 | 1.000E-03 | RTF(11,3)
-34 |                                                        |           |           |
-34 | Th-228+D , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF(12,1)
-34 | Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF(12,2)
-34 | Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF(12,3)
-34 |                                                        |           |           |
-34 | Th-230   , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF(13,1)
 34 | Th-230   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF(13,2)
 34 | Th-230   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF(13,3)
 34 |                                                        |           |           |
 34 | Th-232   , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF(14,1)
 34 | Th-232   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF(14,2)
 34 | Th-232   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 5.000E-06 | 5.000E-06 | RTF(14,3)
 34 |                                                        |           |           |
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ile    : RECCHILD.RAD

                   Dose Conversion Factor (and Related) Parameter Summary (continued)
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    |                                                          |  Current  |           | Parameter
enu |                       Parameter                          |   Value   |  Default  |   Name
-34 | U-234     , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(15,1)
-34 | U-234     , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF(15,2)
-34 | U-234     , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF(15,3)
-34 |                                                          |           |           |
-34 | U-235+D   , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(16,1)
-34 | U-235+D   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF(16,2)
-34 | U-235+D   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF(16,3)
-34 |                                                          |           |           |
-34 | U-236     , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(17,1)
-34 | U-236     , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF(17,2)
-34 | U-236     , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF(17,3)
-34 |                                                          |           |           |
-34 | U-238+D   , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(18,1)
-34 | U-238+D   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF(18,2)
-34 | U-238+D   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 6.000E-04 | 6.000E-04 | RTF(18,3)
    |                                                          |           |           |
-5  | Bioaccumulation factors, fresh water, L/kg:              |           |           |
-5  | Ac-227+D , fish                                          | 1.500E+01 | 1.500E+01 | BIOFAC( 1,1)
-5  | Ac-227+D , crustacea and mollusks                        | 1.000E+03 | 1.000E+03 | BIOFAC( 1,2)
-5  |                                                          |           |           |
-5  | Co-57     , fish                                         | 3.000E+02 | 3.000E+02 | BIOFAC( 2,1)
-5  | Co-57     , crustacea and mollusks                       | 2.000E+02 | 2.000E+02 | BIOFAC( 2,2)
-5  |                                                          |           |           |
-5  | Co-60     , fish                                         | 3.000E+02 | 3.000E+02 | BIOFAC( 3,1)
-5  | Co-60     , crustacea and mollusks                       | 2.000E+02 | 2.000E+02 | BIOFAC( 3,2)
-5  |                                                          |           |           |
-5  | Cs-137+D , fish                                          | 2.000E+03 | 2.000E+03 | BIOFAC( 4,1)
-5  | Cs-137+D , crustacea and mollusks                        | 1.000E+02 | 1.000E+02 | BIOFAC( 4,2)
-5  |                                                          |           |           |
-5  | H-3       , fish                                         | 1.000E+00 | 1.000E+00 | BIOFAC( 5,1)
-5  | H-3       , crustacea and mollusks                       | 1.000E+00 | 1.000E+00 | BIOFAC( 5,2)
-5  |                                                          |           |           |
-5  | Pa-231    , fish                                         | 1.000E+01 | 1.000E+01 | BIOFAC( 6,1)
-5  | Pa-231    , crustacea and mollusks                       | 1.100E+02 | 1.100E+02 | BIOFAC( 6,2)
-5  |                                                          |           |           |
-5  | Pb-210+D , fish                                          | 3.000E+02 | 3.000E+02 | BIOFAC( 7,1)
-5  | Pb-210+D , crustacea and mollusks                        | 1.000E+02 | 1.000E+02 | BIOFAC( 7,2)
-5  |                                                          |           |           |
-5  | Pu-239    , fish                                         | 3.000E+01 | 3.000E+01 | BIOFAC( 8,1)
-5  | Pu-239    , crustacea and mollusks                       | 1.000E+02 | 1.000E+02 | BIOFAC( 8,2)
-5  |                                                          |           |           |
-5  | Pu-240    , fish                                         | 3.000E+01 | 3.000E+01 | BIOFAC( 9,1)
-5  | Pu-240    , crustacea and mollusks                       | 1.000E+02 | 1.000E+02 | BIOFAC( 9,2)
-5  |                                                          |           |           |
-5  | Ra-226+D , fish                                          | 5.000E+01 | 5.000E+01 | BIOFAC(10,1)
-5  | Ra-226+D , crustacea and mollusks                        | 2.500E+02 | 2.500E+02 | BIOFAC(10,2)
-5  |                                                          |           |           |
-5  | Ra-228+D , fish                                          | 5.000E+01 | 5.000E+01 | BIOFAC(11,1)
-5  | Ra-228+D , crustacea and mollusks                        | 2.500E+02 | 2.500E+02 | BIOFAC(11,2)
-5  |                                                          |           |           |
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Dose Conversion Factor (and Related) Parameter Summary (continued)
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enu	Parameter	Current Value	Default	Parameter Name
-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(12,1)
-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(12,2)
-5				
-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(13,1)
-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(13,2)
-5				
-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(14,1)
-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(14,2)
-5				
-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(15,1)
-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(15,2)
-5				
-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(16,1)
-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(16,2)
-5				
-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(17,1)
-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(17,2)
-5				
-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(18,1)
-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(18,2)

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                                   Site-Specific Parameter Summary

    |                                                      |   User    |           |         Used by RESRAD           |  Parameter
lenu |                  Parameter                           |   Input   |  Default  | (If different from user input)   |    Name
-----+------------------------------------------------------+-----------+-----------+----------------------------------+-------------
.011 | Area of contaminated zone (m**2)                     | 3.439E+03 | 1.000E+04 |               ---                | AREA
:011 | Thickness of contaminated zone (m)                   | 2.000E+00 | 2.000E+00 |               ---                | THICK0
:011 | Length parallel to aquifer flow (m)                  | 6.100E+01 | 1.000E+02 |               ---                | LCZPAQ
:011 | Basic radiation dose limit (mrem/yr)                 | 1.000E+01 | 3.000E+01 |               ---                | BRDL
:011 | Time since placement of material (yr)                | 0.000E+00 | 0.000E+00 |               ---                | TI
:011 | Times for calculations (yr)                          | 1.000E+00 | 1.000E+00 |               ---                | T( 2)
:011 | Times for calculations (yr)                          | 5.000E+00 | 3.000E+00 |               ---                | T( 3)
:011 | Times for calculations (yr)                          | 1.000E+01 | 1.000E+01 |               ---                | T( 4)
:011 | Times for calculations (yr)                          | 2.500E+01 | 3.000E+01 |               ---                | T( 5)
:011 | Times for calculations (yr)                          | 4.000E+01 | 1.000E+02 |               ---                | T( 6)
:011 | Times for calculations (yr)                          | 5.500E+01 | 3.000E+02 |               ---                | T( 7)
:011 | Times for calculations (yr)                          | 7.000E+01 | 1.000E+03 |               ---                | T( 8)
:011 | Times for calculations (yr)                          | not used  | 0.000E+00 |               ---                | T( 9)
:011 | Times for calculations (yr)                          | not used  | 0.000E+00 |               ---                | T(10)
     |                                                      |           |           |                                  |
:012 | Initial principal radionuclide (pCi/g):   Ac-227     | 1.000E+00 | 0.000E+00 |               ---                | S1( 1)
:012 | Initial principal radionuclide (pCi/g):   Co-57      | 1.000E+00 | 0.000E+00 |               ---                | S1( 2)
:012 | Initial principal radionuclide (pCi/g):   Co-60      | 1.000E+00 | 0.000E+00 |               ---                | S1( 3)
:012 | Initial principal radionuclide (pCi/g):   Cs-137     | 1.000E+00 | 0.000E+00 |               ---                | S1( 4)
:012 | Initial principal radionuclide (pCi/g):   H-3        | 1.000E+00 | 0.000E+00 |               ---                | S1( 5)
:012 | Initial principal radionuclide (pCi/g):   Pa-231     | 1.000E+00 | 0.000E+00 |               ---                | S1( 6)
:012 | Initial principal radionuclide (pCi/g):   Pb-210     | 1.000E+00 | 0.000E+00 |               ---                | S1( 7)
:012 | Initial principal radionuclide (pCi/g):   Pu-239     | 1.000E+00 | 0.000E+00 |               ---                | S1( 8)
:012 | Initial principal radionuclide (pCi/g):   Pu-240     | 1.000E+00 | 0.000E+00 |               ---                | S1( 9)
:012 | Initial principal radionuclide (pCi/g):   Ra-226     | 1.000E+00 | 0.000E+00 |               ---                | S1(10)
:012 | Initial principal radionuclide (pCi/g):   Ra-228     | 1.000E+00 | 0.000E+00 |               ---                | S1(11)
:012 | Initial principal radionuclide (pCi/g):   Th-228     | 1.000E+00 | 0.000E+00 |               ---                | S1(12)
:012 | Initial principal radionuclide (pCi/g):   Th-230     | 1.000E+00 | 0.000E+00 |               ---                | S1(13)
:012 | Initial principal radionuclide (pCi/g):   Th-232     | 1.000E+00 | 0.000E+00 |               ---                | S1(14)
:012 | Initial principal radionuclide (pCi/g):   U-234      | 1.000E+00 | 0.000E+00 |               ---                | S1(15)
:012 | Initial principal radionuclide (pCi/g):   U-235      | 1.000E+00 | 0.000E+00 |               ---                | S1(16)
:012 | Initial principal radionuclide (pCi/g):   U-238      | 1.000E+00 | 0.000E+00 |               ---                | S1(18)
R012 | Concentration in groundwater   (pCi/L):   Ac-227     | not used  | 0.000E+00 |               ---                | W1( 1)
R012 | Concentration in groundwater   (pCi/L):   Co-57      | not used  | 0.000E+00 |               ---                | W1( 2)
R012 | Concentration in groundwater   (pCi/L):   Co-60      | not used  | 0.000E+00 |               ---                | W1( 3)
R012 | Concentration in groundwater   (pCi/L):   Cs-137     | not used  | 0.000E+00 |               ---                | W1( 4)
R012 | Concentration in groundwater   (pCi/L):   H-3        | not used  | 0.000E+00 |               ---                | W1( 5)
R012 | Concentration in groundwater   (pCi/L):   Pa-231     | not used  | 0.000E+00 |               ---                | W1( 6)
R012 | Concentration in groundwater   (pCi/L):   Pb-210     | not used  | 0.000E+00 |               ---                | W1( 7)
R012 | Concentration in groundwater   (pCi/L):   Pu-239     | not used  | 0.000E+00 |               ---                | W1( 8)
R012 | Concentration in groundwater   (pCi/L):   Pu-240     | not used  | 0.000E+00 |               ---                | W1( 9)
R012 | Concentration in groundwater   (pCi/L):   Ra-226     | not used  | 0.000E+00 |               ---                | W1(10)
R012 | Concentration in groundwater   (pCi/L):   Ra-228     | not used  | 0.000E+00 |               ---                | W1(11)
R012 | Concentration in groundwater   (pCi/L):   Th-228     | not used  | 0.000E+00 |               ---                | W1(12)
R012 | Concentration in groundwater   (pCi/L):   Th-230     | not used  | 0.000E+00 |               ---                | W1(13)
R012 | Concentration in groundwater   (pCi/L):   Th-232     | not used  | 0.000E+00 |               ---                | W1(14)
R012 | Concentration in groundwater   (pCi/L):   U-234      | not used  | 0.000E+00 |               ---                | W1(15)
R012 | Concentration in groundwater   (pCi/L):   U-235      | not used  | 0.000E+00 |               ---                | W1(16)
R012 | Concentration in groundwater   (pCi/L):   U-238      | not used  | 0.000E+00 |               ---                | W1(18)
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                                   Site-Specific Parameter Summary (continued)

    |                                                  |   User     |            |        Used by RESRAD              |  Parameter
enu |                   Parameter                      |   Input    |  Default   | (If different from user input)     |    Name
----+--------------------------------------------------+------------+------------+------------------------------------+-------------
013 | Cover depth (m)                                  | 0.000E+00  | 0.000E+00  |              ---                   | COVER0
013 | Density of cover material (g/cm**3)              | not used   | 1.500E+00  |              ---                   | DENSCV
013 | Cover depth erosion rate (m/yr)                  | not used   | 1.000E-03  |              ---                   | VCV
013 | Density of contaminated zone (g/cm**3)           | 1.500E+00  | 1.500E+00  |              ---                   | DENSCZ
013 | Contaminated zone erosion rate (m/yr)            | 6.000E-05  | 1.000E-03  |              ---                   | VCZ
013 | Contaminated zone total porosity                 | 3.700E-01  | 4.000E-01  |              ---                   | TPCZ
013 | Contaminated zone effective porosity             | 1.750E-01  | 2.000E-01  |              ---                   | EPCZ
013 | Contaminated zone hydraulic conductivity (m/yr)  | 2.080E+02  | 1.000E+01  |              ---                   | HCCZ
013 | Contaminated zone b parameter                    | 7.750E+00  | 5.300E+00  |              ---                   | BCZ
013 | Average annual wind speed (m/sec)                | 3.000E+00  | 2.000E+00  |              ---                   | WIND
013 | Humidity in air (g/m**3)                         | 6.600E+00  | 8.000E+00  |              ---                   | HUMID
013 | Evapotranspiration coefficient                   | 7.100E-01  | 5.000E-01  |              ---                   | EVAPTR
013 | Precipitation (m/yr)                             | 7.500E-01  | 1.000E+00  |              ---                   | PRECIP
013 | Irrigation (m/yr)                                | 0.000E+00  | 2.000E-01  |              ---                   | RI
013 | Irrigation mode                                  | overhead   | overhead   |              ---                   | IDITCH
013 | Runoff coefficient                               | 2.000E-01  | 2.000E-01  |              ---                   | RUNOFF
013 | Watershed area for nearby stream or pond (m**2)  | 1.300E+07  | 1.000E+06  |              ---                   | WAREA
013 | Accuracy for water/soil computations             | 1.000E-03  | 1.000E-03  |              ---                   | EPS
    |                                                  |            |            |                                    |
014 | Density of saturated zone (g/cm**3)              | 1.500E+00  | 1.500E+00  |              ---                   | DENSAQ
014 | Saturated zone total porosity                    | 3.700E-01  | 4.000E-01  |              ---                   | TPSZ
014 | Saturated zone effective porosity                | 1.750E-01  | 2.000E-01  |              ---                   | EPSZ
014 | Saturated zone hydraulic conductivity (m/yr)     | 2.080E+02  | 1.000E+02  |              ---                   | HCSZ
014 | Saturated zone hydraulic gradient                | 1.200E-02  | 2.000E-02  |              ---                   | HGWT
014 | Saturated zone b parameter                       | 1.040E+01  | 5.300E+00  |              ---                   | BSZ
014 | Water table drop rate (m/yr)                     | 0.000E+00  | 1.000E-03  |              ---                   | VWT
014 | Well pump intake depth (m below water table)     | 3.000E+00  | 1.000E+01  |              ---                   | DWIBWT
014 | Model: Nondispersion (ND) or Mass-Balance (MB)   | ND         | ND         |              ---                   | MODEL
014 | Well pumping rate (m**3/yr)                      | 5.000E+01  | 2.500E+02  |              ---                   | UW
    |                                                  |            |            |                                    |
015 | Number of unsaturated zone strata                | 1          | 1          |              ---                   | NS
015 | Unsat. zone 1, thickness (m)                     | 1.000E+00  | 4.000E+00  |              ---                   | H(1)
015 | Unsat. zone 1, soil density (g/cm**3)            | 1.500E+00  | 1.500E+00  |              ---                   | DENSUZ(1)
015 | Unsat. zone 1, total porosity                    | 3.700E-01  | 4.000E-01  |              ---                   | TPUZ(1)
015 | Unsat. zone 1, effective porosity                | 1.750E-01  | 2.000E-01  |              ---                   | EPUZ(1)
015 | Unsat. zone 1, soil-specific b parameter         | 7.750E+00  | 5.300E+00  |              ---                   | BUZ(1)
015 | Unsat. zone 1, hydraulic conductivity (m/yr)     | 2.080E+02  | 1.000E+01  |              ---                   | HCUZ(1)
    |                                                  |            |            |                                    |
016 | Distribution coefficients for Ac-227             |            |            |                                    |
016 |   Contaminated zone (cm**3/g)                    | 2.000E+01  | 2.000E+01  |              ---                   | DCNUCC( 1)
016 |   Unsaturated zone 1 (cm**3/g)                   | 2.000E+01  | 2.000E+01  |              ---                   | DCNUCU( 1,1)
016 |   Saturated zone (cm**3/g)                       | 2.000E+01  | 2.000E+01  |              ---                   | DCNUCS( 1)
016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           2.876E-03                | ALEACH( 1)
016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 1)
    |                                                  |            |            |                                    |
016 | Distribution coefficients for Co-57              |            |            |                                    |
016 |   Contaminated zone (cm**3/g)                    | 1.000E+03  | 1.000E+03  |              ---                   | DCNUCC( 2)
016 |   Unsaturated zone 1 (cm**3/g)                   | 1.000E+03  | 1.000E+03  |              ---                   | DCNUCU( 2,1)
016 |   Saturated zone (cm**3/g)                       | 1.000E+03  | 1.000E+03  |              ---                   | DCNUCS( 2)
016 |   Leach rate (/yr)                               | 0.000E+00  | 0.000E+00  |           5.799E-05                | ALEACH( 2)
016 |   Solubility constant                            | 0.000E+00  | 0.000E+00  |           not used                 | SOLUBK( 2)
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                                 Site-Specific Parameter Summary (continued)

     |                                                    |    User    |            |     Used by RESRAD               |  Parameter
enu  |                    Parameter                       |    Input   |  Default   | (If different from user input)   |    Name
-----+----------------------------------------------------+------------+------------+----------------------------------+-------------
016  | Distribution coefficients for Co-60                |            |            |                                  |
016  |   Contaminated zone (cm**3/g)                      | 1.000E+03  | 1.000E+03  |               ---                |  DCNUCC( 3)
016  |   Unsaturated zone 1 (cm**3/g)                     | 1.000E+03  | 1.000E+03  |               ---                |  DCNUCU( 3,1)
016  |   Saturated zone (cm**3/g)                         | 1.000E+03  | 1.000E+03  |               ---                |  DCNUCS( 3)
016  |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |            5.799E-05             |  ALEACH( 3)
016  |   Solubility constant                              | 0.000E+00  | 0.000E+00  |            not used              |  SOLUBK( 3)
     |                                                    |            |            |                                  |
016  | Distribution coefficients for Cs-137               |            |            |                                  |
016  |   Contaminated zone (cm**3/g)                      | 1.000E+03  | 1.000E+03  |               ---                |  DCNUCC( 4)
016  |   Unsaturated zone 1 (cm**3/g)                     | 1.000E+03  | 1.000E+03  |               ---                |  DCNUCU( 4,1)
016  |   Saturated zone (cm**3/g)                         | 1.000E+03  | 1.000E+03  |               ---                |  DCNUCS( 4)
016  |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |            5.799E-05             |  ALEACH( 4)
016  |   Solubility constant                              | 0.000E+00  | 0.000E+00  |            not used              |  SOLUBK( 4)
     |                                                    |            |            |                                  |
016  | Distribution coefficients for H-3                  |            |            |                                  |
016  |   Contaminated zone (cm**3/g)                      | 0.000E+00  | 0.000E+00  |               ---                |  DCNUCC( 5)
016  |   Unsaturated zone 1 (cm**3/g)                     | 0.000E+00  | 0.000E+00  |               ---                |  DCNUCU( 5,1)
016  |   Saturated zone (cm**3/g)                         | 0.000E+00  | 0.000E+00  |               ---                |  DCNUCS( 5)
016  |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |            3.449E-01             |  ALEACH( 5)
016  |   Solubility constant                              | 0.000E+00  | 0.000E+00  |            not used              |  SOLUBK( 5)
     |                                                    |            |            |                                  |
016  | Distribution coefficients for Pa-231               |            |            |                                  |
016  |   Contaminated zone (cm**3/g)                      | 5.000E+01  | 5.000E+01  |               ---                |  DCNUCC( 6)
016  |   Unsaturated zone 1 (cm**3/g)                     | 5.000E+01  | 5.000E+01  |               ---                |  DCNUCU( 6,1)
016  |   Saturated zone (cm**3/g)                         | 5.000E+01  | 5.000E+01  |               ---                |  DCNUCS( 6)
016  |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |            1.156E-03             |  ALEACH( 6)
016  |   Solubility constant                              | 0.000E+00  | 0.000E+00  |            not used              |  SOLUBK( 6)
     |                                                    |            |            |                                  |
R016 | Distribution coefficients for Pb-210               |            |            |                                  |
R016 |   Contaminated zone (cm**3/g)                      | 1.000E+02  | 1.000E+02  |               ---                |  DCNUCC( 7)
R016 |   Unsaturated zone 1 (cm**3/g)                     | 1.000E+02  | 1.000E+02  |               ---                |  DCNUCU( 7,1)
R016 |   Saturated zone (cm**3/g)                         | 1.000E+02  | 1.000E+02  |               ---                |  DCNUCS( 7)
R016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |            5.790E-04             |  ALEACH( 7)
R016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |            not used              |  SOLUBK( 7)
     |                                                    |            |            |                                  |
R016 | Distribution coefficients for Pu-239               |            |            |                                  |
R016 |   Contaminated zone (cm**3/g)                      | 2.000E+03  | 2.000E+03  |               ---                |  DCNUCC( 8)
R016 |   Unsaturated zone 1 (cm**3/g)                     | 2.000E+03  | 2.000E+03  |               ---                |  DCNUCU( 8,1)
R016 |   Saturated zone (cm**3/g)                         | 2.000E+03  | 2.000E+03  |               ---                |  DCNUCS( 8)
R016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |            2.900E-05             |  ALEACH( 8)
R016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |            not used              |  SOLUBK( 8)
     |                                                    |            |            |                                  |
R016 | Distribution coefficients for Pu-240               |            |            |                                  |
R016 |   Contaminated zone (cm**3/g)                      | 2.000E+03  | 2.000E+03  |               ---                |  DCNUCC( 9)
R016 |   Unsaturated zone 1 (cm**3/g)                     | 2.000E+03  | 2.000E+03  |               ---                |  DCNUCU( 9,1)
R016 |   Saturated zone (cm**3/g)                         | 2.000E+03  | 2.000E+03  |               ---                |  DCNUCS( 9)
R016 |   Leach rate (/yr)                                 | 0.000E+00  | 0.000E+00  |            2.900E-05             |  ALEACH( 9)
R016 |   Solubility constant                              | 0.000E+00  | 0.000E+00  |            not used              |  SOLUBK( 9)
```

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                                        Site-Specific Parameter Summary (continued)

     |                                                 |    User    |            |         Used by RESRAD             |  Parameter
Menu |                   Parameter                     |    Input   |  Default   |  (If different from user input)    |    Name
-----+-------------------------------------------------+------------+------------+------------------------------------+--------------
R016 | Distribution coefficients for Ra-226            |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                   |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCC(10)
R016 |   Unsaturated zone 1 (cm**3/g)                  |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCU(10,1)
R016 |   Saturated zone (cm**3/g)                      |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCS(10)
R016 |   Leach rate (/yr)                              |  0.000E+00 |  0.000E+00 |             8.266E-04              | ALEACH(10)
R016 |   Solubility constant                           |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(10)
     |                                                 |            |            |                                    |
R016 | Distribution coefficients for Ra-228            |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                   |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCC(11)
R016 |   Unsaturated zone 1 (cm**3/g)                  |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCU(11,1)
R016 |   Saturated zone (cm**3/g)                      |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCS(11)
R016 |   Leach rate (/yr)                              |  0.000E+00 |  0.000E+00 |             8.266E-04              | ALEACH(11)
R016 |   Solubility constant                           |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(11)
     |                                                 |            |            |                                    |
 016 | Distribution coefficients for Th-228            |            |            |                                    |
 016 |   Contaminated zone (cm**3/g)                   |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCC(12)
 016 |   Unsaturated zone 1 (cm**3/g)                  |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCU(12,1)
 016 |   Saturated zone (cm**3/g)                      |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCS(12)
 016 |   Leach rate (/yr)                              |  0.000E+00 |  0.000E+00 |             9.667E-07              | ALEACH(12)
 016 |   Solubility constant                           |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(12)
     |                                                 |            |            |                                    |
 016 | Distribution coefficients for Th-230            |            |            |                                    |
 016 |   Contaminated zone (cm**3/g)                   |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCC(13)
 016 |   Unsaturated zone 1 (cm**3/g)                  |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCU(13,1)
 016 |   Saturated zone (cm**3/g)                      |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCS(13)
 016 |   Leach rate (/yr)                              |  0.000E+00 |  0.000E+00 |             9.667E-07              | ALEACH(13)
 016 |   Solubility constant                           |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(13)
     |                                                 |            |            |                                    |
 016 | Distribution coefficients for Th-232            |            |            |                                    |
 016 |   Contaminated zone (cm**3/g)                   |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCC(14)
 016 |   Unsaturated zone 1 (cm**3/g)                  |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCU(14,1)
 016 |   Saturated zone (cm**3/g)                      |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCS(14)
 016 |   Leach rate (/yr)                              |  0.000E+00 |  0.000E+00 |             9.667E-07              | ALEACH(14)
 016 |   Solubility constant                           |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(14)
     |                                                 |            |            |                                    |
 016 | Distribution coefficients for U-234             |            |            |                                    |
 016 |   Contaminated zone (cm**3/g)                   |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCC(15)
 016 |   Unsaturated zone 1 (cm**3/g)                  |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCU(15,1)
 016 |   Saturated zone (cm**3/g)                      |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCS(15)
 016 |   Leach rate (/yr)                              |  0.000E+00 |  0.000E+00 |             1.156E-03              | ALEACH(15)
 016 |   Solubility constant                           |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(15)
     |                                                 |            |            |                                    |
 016 | Distribution coefficients for U-235             |            |            |                                    |
 016 |   Contaminated zone (cm**3/g)                   |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCC(16)
 016 |   Unsaturated zone 1 (cm**3/g)                  |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCU(16,1)
 016 |   Saturated zone (cm**3/g)                      |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCS(16)
 016 |   Leach rate (/yr)                              |  0.000E+00 |  0.000E+00 |             1.156E-03              | ALEACH(16)
 016 |   Solubility constant                           |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(16)
```

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                                     Site-Specific Parameter Summary (continued)

     |                                                    |   User    |            |         Used by RESRAD           |   Parameter
enu  |                     Parameter                      |   Input   |  Default   | (If different from user input)   |     Name
-----+----------------------------------------------------+-----------+------------+----------------------------------+---------------
016  | Distribution coefficients for U-238                |           |            |                                  |
016  |   Contaminated zone (cm**3/g)                      | 5.000E+01 | 5.000E+01  |               ---                | DCNUCC(18)
016  |   Unsaturated zone 1 (cm**3/g)                     | 5.000E+01 | 5.000E+01  |               ---                | DCNUCU(18,1)
.016 |   Saturated zone (cm**3/g)                         | 5.000E+01 | 5.000E+01  |               ---                | DCNUCS(18)
.016 |   Leach rate (/yr)                                 | 0.000E+00 | 0.000E+00  |            1.156E-03             | ALEACH(18)
.016 |   Solubility constant                              | 0.000E+00 | 0.000E+00  |            not used              | SOLUBK(18)
     |                                                    |           |            |                                  |
.016 | Distribution coefficients for daughter U-236       |           |            |                                  |
.016 |   Contaminated zone (cm**3/g)                      | 5.000E+01 | 5.000E+01  |               ---                | DCNUCC(17)
.016 |   Unsaturated zone 1 (cm**3/g)                     | 5.000E+01 | 5.000E+01  |               ---                | DCNUCU(17,1)
.016 |   Saturated zone (cm**3/g)                         | 5.000E+01 | 5.000E+01  |               ---                | DCNUCS(17)
:016 |   Leach rate (/yr)                                 | 0.000E+00 | 0.000E+00  |            1.156E-03             | ALEACH(17)
016  |   Solubility constant                              | 0.000E+00 | 0.000E+00  |            not used              | SOLUBK(17)
     |                                                    |           |            |                                  |
.017 | Inhalation rate (m**3/yr)                          | 1.220E+02 | 8.400E+03  |               ---                | INHALR
:017 | Mass loading for inhalation (g/m**3)               | 1.000E-04 | 1.000E-04  |               ---                | MLINH
:017 | Exposure duration                                  | 5.000E+00 | 3.000E+01  |               ---                | ED
:017 | Shielding factor, inhalation                       | 4.000E-01 | 4.000E-01  |               ---                | SHF3
:017 | Shielding factor, external gamma                   | 7.000E-01 | 7.000E-01  |               ---                | SHF1
:017 | Fraction of time spent indoors                     | 0.000E+00 | 5.000E-01  |               ---                | FIND
:017 | Fraction of time spent outdoors (on site)          | 3.300E-01 | 2.500E-01  |               ---                | FOTD
:017 | Shape factor flag, external gamma                  | 1.000E+00 | 1.000E+00  |   >0 shows circular AREA.        | FS
:017 | Radii of shape factor array (used if FS = -1):     |           |            |                                  |
017  |   Outer annular radius (m), ring  1:               | not used  | 5.000E+01  |               ---                | RAD SHAPE( 1)
017  |   Outer annular radius (m), ring  2:               | not used  | 7.071E+01  |               ---                | RAD SHAPE( 2)
017  |   Outer annular radius (m), ring  3:               | not used  | 0.000E+00  |               ---                | RAD SHAPE( 3)
017  |   Outer annular radius (m), ring  4:               | not used  | 0.000E+00  |               ---                | RAD SHAPE( 4)
017  |   Outer annular radius (m), ring  5:               | not used  | 0.000E+00  |               ---                | RAD SHAPE( 5)
017  |   Outer annular radius (m), ring  6:               | not used  | 0.000E+00  |               ---                | RAD SHAPE( 6)
017  |   Outer annular radius (m), ring  7:               | not used  | 0.000E+00  |               ---                | RAD SHAPE( 7)
017  |   Outer annular radius (m), ring  8:               | not used  | 0.000E+00  |               ---                | RAD SHAPE( 8)
017  |   Outer annular radius (m), ring  9:               | not used  | 0.000E+00  |               ---                | RAD SHAPE( 9)
017  |   Outer annular radius (m), ring 10:               | not used  | 0.000E+00  |               ---                | RAD SHAPE(10)
017  |   Outer annular radius (m), ring 11:               | not used  | 0.000E+00  |               ---                | RAD SHAPE(11)
017  |   Outer annular radius (m), ring 12:               | not used  | 0.000E+00  |               ---                | RAD_SHAPE(12)
     |                                                    |           |            |                                  |
R017 | Fractions of annular areas within AREA:            |           |            |                                  |
R017 |   Ring  1                                          | not used  | 1.000E+00  |               ---                | FRACA( 1)
R017 |   Ring  2                                          | not used  | 2.732E-01  |               ---                | FRACA( 2)
R017 |   Ring  3                                          | not used  | 0.000E+00  |               ---                | FRACA( 3)
R017 |   Ring  4                                          | not used  | 0.000E+00  |               ---                | FRACA( 4)
R017 |   Ring  5                                          | not used  | 0.000E+00  |               ---                | FRACA( 5)
R017 |   Ring  6                                          | not used  | 0.000E+00  |               ---                | FRACA( 6)
R017 |   Ring  7                                          | not used  | 0.000E+00  |               ---                | FRACA( 7)
R017 |   Ring  8                                          | not used  | 0.000E+00  |               ---                | FRACA( 8)
R017 |   Ring  9                                          | not used  | 0.000E+00  |               ---                | FRACA( 9)
R017 |   Ring 10                                          | not used  | 0.000E+00  |               ---                | FRACA(10)
R017 |   Ring 11                                          | not used  | 0.000E+00  |               ---                | FRACA(11)
R017 |   Ring 12                                          | not used  | 0.000E+00  |               ---                | FRACA(12)
```

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                                     Site-Specific Parameter Summary (continued)

    |                                               |   User    |             |       Used by RESRAD             | Parameter
enu |                 Parameter                     |   Input   |   Default   | (If different from user input)  |   Name
----------------------------------------------------------------------------------------------------------------------------
018 | Fruits, vegetables and grain consumption (kg/yr) | not used  | 1.600E+02 |      ---                         | DIET(1)
018 | Leafy vegetable consumption (kg/yr)           | not used  | 1.400E+01  |      ---                         | DIET(2)
018 | Milk consumption (L/yr)                       | not used  | 9.200E+01  |      ---                         | DIET(3)
018 | Meat and poultry consumption (kg/yr)          | not used  | 6.300E+01  |      ---                         | DIET(4)
018 | Fish consumption (kg/yr)                      | not used  | 5.400E+00  |      ---                         | DIET(5)
018 | Other seafood consumption (kg/yr)             | not used  | 9.000E-01  |      ---                         | DIET(6)
018 | Soil ingestion rate (g/yr)                    | 2.800E+00 | 3.650E+01  |      ---                         | SOIL
018 | Drinking water intake (L/yr)                  | 1.400E+01 | 5.100E+02  |      ---                         | DWI
018 | Contamination fraction of drinking water      | 1.000E+00 | 1.000E+00  |      ---                         | FDW
018 | Contamination fraction of household water     | not used  | 1.000E+00  |      ---                         | FHHW
018 | Contamination fraction of livestock water     | not used  | 1.000E+00  |      ---                         | FLW
018 | Contamination fraction of irrigation water    | not used  | 1.000E+00  |      ---                         | FIRW
018 | Contamination fraction of aquatic food        | not used  | 5.000E-01  |      ---                         | FR9
018 | Contamination fraction of plant food          | not used  |-1          |      ---                         | FPLANT
018 | Contamination fraction of meat                | not used  |-1          |      ---                         | FMEAT
018 | Contamination fraction of milk                | not used  |-1          |      ---                         | FMILK
    |                                               |           |            |                                  |
019 | Livestock fodder intake for meat (kg/day)     | not used  | 6.800E+01  |      ---                         | LFI5
019 | Livestock fodder intake for milk (kg/day)     | not used  | 5.500E+01  |      ---                         | LFI6
019 | Livestock water intake for meat (L/day)       | not used  | 5.000E+01  |      ---                         | LWI5
019 | Livestock water intake for milk (L/day)       | not used  | 1.600E+02  |      ---                         | LWI6
019 | Livestock soil intake (kg/day)                | not used  | 5.000E-01  |      ---                         | LSI
019 | Mass loading for foliar deposition (g/m**3)   | not used  | 1.000E-04  |      ---                         | MLFD
019 | Depth of soil mixing layer (m)                | 1.500E-01 | 1.500E-01  |      ---                         | DM
019 | Depth of roots (m)                            | not used  | 9.000E-01  |      ---                         | DROOT
019 | Drinking water fraction from ground water     | 1.000E+00 | 1.000E+00  |      ---                         | FGWDW
019 | Household water fraction from ground water    | 1.000E+00 | 1.000E+00  |      ---                         | FGWHH
019 | Livestock water fraction from ground water    | not used  | 1.000E+00  |      ---                         | FGWLW
019 | Irrigation fraction from ground water         | not used  | 1.000E+00  |      ---                         | FGWIR
    |                                               |           |            |                                  |
19B | Wet weight crop yield for Non-Leafy (kg/m**2) | not used  | 7.000E-01  |      ---                         | YV(1)
19B | Wet weight crop yield for Leafy     (kg/m**2) | not used  | 1.500E+00  |      ---                         | YV(2)
19B | Wet weight crop yield for Fodder    (kg/m**2) | not used  | 1.100E+00  |      ---                         | YV(3)
19B | Growing Season for  Non-Leafy (years)         | not used  | 1.700E-01  |      ---                         | TE(1)
19B | Growing Season for  Leafy     (years)         | not used  | 2.500E-01  |      ---                         | TE(2)
19B | Growing Season for  Fodder    (years)         | not used  | 8.000E-02  |      ---                         | TE(3)
19B | Translocation Factor for  Non-Leafy           | not used  | 1.000E-01  |      ---                         | TIV(1)
19B | Translocation Factor for  Leafy               | not used  | 1.000E+00  |      ---                         | TIV(2)
19B | Translocation Factor for  Fodder              | not used  | 1.000E+00  |      ---                         | TIV(3)
19B | Dry Foliar Interception Fraction for  Non-Leafy | not used | 2.500E-01 |      ---                         | RDRY(1)
19B | Dry Foliar Interception Fraction for  Leafy   | not used  | 2.500E-01  |      ---                         | RDRY(2)
19B | Dry Foliar Interception Fraction for  Fodder  | not used  | 2.500E-01  |      ---                         | RDRY(3)
19B | Wet Foliar Interception Fraction for  Non-Leafy | not used | 2.500E-01 |      ---                         | RWET(1)
19B | Wet Foliar Interception Fraction for  Leafy   | not used  | 2.500E-01  |      ---                         | RWET(2)
19B | Wet Foliar Interception Fraction for  Fodder  | not used  | 2.500E-01  |      ---                         | RWET(3)
19B | Weathering Removal Constant for Vegetation    | not used  | 2.000E+01  |      ---                         | WLAM
    |                                               |           |            |                                  |
14  | C-12 concentration in water (g/cm**3)         | not used  | 2.000E-05  |      ---                         | C12WTR
14  | C-12 concentration in contaminated soil (g/g) | not used  | 3.000E-02  |      ---                         | C12CZ
14  | Fraction of vegetation carbon from soil       | not used  | 2.000E-02  |      ---                         | CSOIL
```

```
                         Site-Specific Parameter Summary (continued)

     |                                                    |   User    |            |        Used by RESRAD         | Parameter
Menu |                     Parameter                      |   Input   |  Default   | (If different from user input)|   Name
-----+----------------------------------------------------+-----------+------------+-------------------------------+-----------
C14  | Fraction of vegetation carbon from air             | not used  |  9.800E-01 |              ---              | CAIR
C14  | C-14 evasion layer thickness in soil (m)           | not used  |  3.000E-01 |              ---              | DMC
C14  | C-14 evasion flux rate from soil (1/sec)           | not used  |  7.000E-07 |              ---              | EVSN
C14  | C-12 evasion flux rate from soil (1/sec)           | not used  |  1.000E-10 |              ---              | REVSN
C14  | Fraction of grain in beef cattle feed              | not used  |  8.000E-01 |              ---              | AVFG4
C14  | Fraction of grain in milk cow feed                 | not used  |  2.000E-01 |              ---              | AVFG5
     |                                                    |           |            |                               |
STOR | Storage times of contaminated foodstuffs (days):   |           |            |                               |
STOR |   Fruits, non-leafy vegetables, and grain          | 1.400E+01 |  1.400E+01 |              ---              | STOR_T(1)
STOR |   Leafy vegetables                                 | 1.000E+00 |  1.000E+00 |              ---              | STOR_T(2)
STOR |   Milk                                             | 1.000E+00 |  1.000E+00 |              ---              | STOR_T(3)
STOR |   Meat and poultry                                 | 2.000E+01 |  2.000E+01 |              ---              | STOR_T(4)
STOR |   Fish                                             | 7.000E+00 |  7.000E+00 |              ---              | STOR_T(5)
STOR |   Crustacea and mollusks                           | 7.000E+00 |  7.000E+00 |              ---              | STOR_T(6)
STOR |   Well water                                       | 1.000E+00 |  1.000E+00 |              ---              | STOR_T(7)
STOR |   Surface water                                    | 1.000E+00 |  1.000E+00 |              ---              | STOR_T(8)
STOR |   Livestock fodder                                 | 4.500E+01 |  4.500E+01 |              ---              | STOR_T(9)
     |                                                    |           |            |                               |
R021 | Thickness of building foundation (m)               | not used  |  1.500E-01 |              ---              | FLOOR
R021 | Bulk density of building foundation (g/cm**3)      | not used  |  2.400E+00 |              ---              | DENSFL
R021 | Total porosity of the cover material               | not used  |  4.000E-01 |              ---              | TPCV
R021 | Total porosity of the building foundation          | not used  |  1.000E-01 |              ---              | TPFL
R021 | Volumetric water content of the cover material     | not used  |  5.000E-02 |              ---              | PH2OCV
R021 | Volumetric water content of the foundation         | not used  |  3.000E-02 |              ---              | PH2OFL
R021 | Diffusion coefficient for radon gas (m/sec):       |           |            |                               |
R021 |   in cover material                                | not used  |  2.000E-06 |              ---              | DIFCV
R021 |   in foundation material                           | not used  |  3.000E-07 |              ---              | DIFFL
R021 |   in contaminated zone soil                        | not used  |  2.000E-06 |              ---              | DIFCZ
R021 | Radon vertical dimension of mixing (m)             | not used  |  2.000E+00 |              ---              | HMIX
R021 | Average building air exchange rate (1/hr)          | not used  |  5.000E-01 |              ---              | REXG
R021 | Height of the building (room) (m)                  | not used  |  2.500E+00 |              ---              | HRM
R021 | Building interior area factor                      | not used  |  0.000E+00 |              ---              | FAI
R021 | Building depth below ground surface (m)            | not used  | -1.000E+00 |              ---              | DMFL
R021 | Emanating power of Rn-222 gas                      | not used  |  2.500E-01 |              ---              | EMANA(1)
R021 | Emanating power of Rn-220 gas                      | not used  |  1.500E-01 |              ---              | EMANA(2)
=====+====================================================+===========+============+===============================+===========
```

```
              Summary of Pathway Selections

          Pathway                  |    User Selection
-----------------------------------|---------------------
  1 -- external gamma              |       active
  2 -- inhalation (w/o radon)      |       active
  3 -- plant ingestion             |     suppressed
  4 -- meat ingestion              |     suppressed
  5 -- milk ingestion              |     suppressed
  6 -- aquatic foods               |     suppressed
  7 -- drinking water              |       active
  8 -- soil ingestion              |       active
  9 -- radon                       |     suppressed
  Find peak pathway doses          |     suppressed
===================================|=====================
```

```
     Contaminated Zone Dimensions          Initial Soil Concentrations, pCi/g
     ____________________________          __________________________________

       Area:   3439.00 square meters              Ac-227      1.000E+00
  Thickness:      2.00 meters                     Co-57       1.000E+00
Cover Depth:      0.00 meters                     Co-60       1.000E+00
                                                  Cs-137      1.000E+00
                                                  H-3         1.000E+00
                                                  Pa-231      1.000E+00
                                                  Pb-210      1.000E+00
                                                  Pu-239      1.000E+00
                                                  Pu-240      1.000E+00
                                                  Ra-226      1.000E+00
                                                  Ra-228      1.000E+00
                                                  Th-228      1.000E+00
                                                  Th-230      1.000E+00
                                                  Th-232      1.000E+00
                                                  U-234       1.000E+00
                                                  U-235       1.000E+00
                                                  U-238       1.000E+00

                                   Total Dose TDOSE(t), mrem/yr
                              Basic Radiation Dose Limit =  10 mrem/yr
                 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                 _________________________________________________________________________

  t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
   TDOSE(t):  1.539E+01  1.466E+01  1.273E+01  1.137E+01  9.917E+00  9.527E+00  9.328E+00  9.184E+00
       M(t):  1.539E+00  1.466E+00  1.273E+00  1.137E+00  9.917E-01  9.527E-01  9.328E-01  9.184E-01

Maximum TDOSE(t):  1.539E+01 mrem/yr   at t = 0.000E+00 years
```

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                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                        Water Independent Pathways (Inhalation excludes radon)

             Ground             Inhalation            Radon               Plant               Meat                Milk                Soil
adio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
clide   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
-227    6.133E-01 0.0399   3.567E-03 0.0002   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.368E-02 0.0009
-57     1.549E-01 0.0101   4.815E-09 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.090E-06 0.0000
-60     4.903E+00 0.3186   1.163E-07 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.486E-05 0.0000
-137    1.025E+00 0.0666   1.693E-08 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.620E-05 0.0000
-3      0.000E+00 0.0000   4.596E-06 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   5.914E-08 0.0000
-231    5.861E-02 0.0038   6.795E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.794E-03 0.0006
-210    1.924E-03 0.0001   1.232E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.717E-03 0.0004
-239    9.180E-05 0.0000   2.277E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.271E-03 0.0002
-240    4.749E-05 0.0000   2.277E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.271E-03 0.0002
-226    3.396E+00 0.2207   4.566E-06 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.229E-03 0.0001
-228    1.811E+00 0.1177   2.697E-06 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.331E-03 0.0001
-228    3.100E+00 0.2014   1.832E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   7.466E-04 0.0000
-230    3.753E-04 0.0000   1.731E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   5.064E-04 0.0000
-232    1.623E-04 0.0000   8.706E-04 0.0001   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.523E-03 0.0002
234     1.258E-04 0.0000   7.008E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.615E-04 0.0000
235     2.329E-01 0.0151   6.530E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.467E-04 0.0000
238     4.161E-02 0.0027   6.264E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.486E-04 0.0000
======  ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
tal     1.534E+01 0.9967   6.152E-03 0.0004   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.389E-02 0.0029
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SRAD, Version 5.82     T½ Limit = 0.5 year        10/15/99  11:54     Page  16
mmary : SEAD-63 Recreational child - Site Specific Parameters
le     : RECCHILD.RAD

                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                       As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                       Water Dependent Pathways

             Water                Fish                Radon                Plant                Meat                 Milk             All Pathways*
dio-    ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
clide   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
-227    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.305E-01  0.0410
-57     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.549E-01  0.0101
-60     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.903E+00  0.3186
-137    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.025E+00  0.0666
-3      0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.655E-06  0.0000
-231    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.908E-02  0.0045
-210    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.653E-03  0.0006
-239    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.591E-03  0.0002
-240    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.546E-03  0.0002
-226    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.397E+00  0.2208
-228    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.813E+00  0.1178
-228    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.101E+00  0.2015
-230    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.055E-03  0.0001
-232    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.555E-03  0.0002
-234    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.574E-04  0.0000
-235    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.332E-01  0.0152
-238    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.192E-02  0.0027
======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
tal     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.539E+01  1.0000

um of all water independent and dependent pathways.
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                                 Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                    Water Independent Pathways (Inhalation excludes radon)

              Ground              Inhalation              Radon                 Plant                 Meat                  Milk                  Soil
adio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
uclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
-------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
c-227   5.923E-01 0.0404  3.446E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.321E-02 0.0009
o-57    6.083E-02 0.0041  1.891E-09 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.282E-07 0.0000
o-60    4.299E+00 0.2932  1.019E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.179E-05 0.0000
s-137   1.001E+00 0.0683  1.655E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.514E-05 0.0000
-3      0.000E+00 0.0000  1.321E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.700E-08 0.0000
a-231   7.772E-02 0.0053  7.903E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.021E-02 0.0007
b-210   1.864E-03 0.0001  1.193E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.508E-03 0.0004
u-239   9.179E-05 0.0000  2.277E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.271E-03 0.0002
u-240   4.748E-05 0.0000  2.277E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.271E-03 0.0002
a-226   3.392E+00 0.2313  4.936E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.433E-03 0.0001
a-228   2.488E+00 0.1697  5.462E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.391E-03 0.0001
h-228   2.158E+00 0.1472  1.275E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.197E-04 0.0000
h-230   1.845E-03 0.0001  1.731E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.069E-04 0.0000
h-232   2.636E-01 0.0180  8.744E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.687E-03 0.0002
-234    1.257E-04 0.0000  7.000E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.612E-04 0.0000
-235    2.326E-01 0.0159  6.524E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.466E-04 0.0000
-238    4.156E-02 0.0028  6.257E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.483E-04 0.0000
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
otal    1.461E+01 0.9966  6.137E-03 0.0004  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.383E-02 0.0030
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                   Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                 Water Dependent Pathways

            Water                Fish                 Radon                Plant                Meat                 Milk             All Pathways*
adio-  -------------------- -------------------- -------------------- -------------------- -------------------- -------------------- --------------------
uclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
c-227  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.090E-01 0.0415
o-57   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.083E-02 0.0041
o-60   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.299E+00 0.2932
s-137  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.001E+00 0.0683
-3     4.931E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.945E-04 0.0000
a-231  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.872E-02 0.0061
b-210  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.384E-03 0.0006
u-239  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.590E-03 0.0002
u-240  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.546E-03 0.0002
a-226  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.393E+00 0.2314
a-228  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.490E+00 0.1698
h-228  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.158E+00 0.1472
h-230  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.525E-03 0.0002
h-232  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.671E-01 0.0182
-234   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.569E-04 0.0000
-235   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.330E-01 0.0159
-238   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.187E-02 0.0029
======= ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
otal   4.931E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.466E+01 1.0000

Sum of all water independent and dependent pathways.
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ESRAD, Vers        2     T½ Limit = 0.5 year        10/15/99  11:5        ge  19
ummary : SEAD- . ecreational child - Site Specific Parameters
ile    : RECCHILD.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                         Water Independent Pathways (Inhalation excludes radon)

          Ground             Inhalation            Radon                Plant                Meat                 Milk                 Soil
adio-  ------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
uclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
------  ---------  ------  ---------  ------   ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
-227    5.156E-01 0.0405   2.999E-03 0.0002   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.150E-02 0.0009
-57     1.447E-03 0.0001   4.499E-11 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.019E-08 0.0000
-60     2.540E+00 0.1996   6.022E-08 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.287E-05 0.0000
-137    9.126E-01 0.0717   1.508E-08 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.115E-05 0.0000
-3      0.000E+00 0.0000   9.009E-09 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.159E-10 0.0000
-231    1.476E-01 0.0116   1.195E-03 0.0001   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.173E-02 0.0009
-210    1.642E-03 0.0001   1.051E-05 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.734E-03 0.0005
-239    9.177E-05 0.0000   2.277E-04 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.270E-03 0.0003
-240    4.746E-05 0.0000   2.276E-04 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.269E-03 0.0003
-226    3.375E+00 0.2652   6.301E-06 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.184E-03 0.0002
-228    2.766E+00 0.2174   1.066E-04 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.154E-03 0.0001
-228    5.065E-01 0.0398   2.993E-05 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.220E-04 0.0000
-230    7.708E-03 0.0006   1.731E-04 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.101E-04 0.0000
-232    1.627E+00 0.1279   9.196E-04 0.0001   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.318E-03 0.0003
-234    1.253E-04 0.0000   6.968E-05 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.600E-04 0.0000
-235    2.316E-01 0.0182   6.502E-05 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.464E-04 0.0000
-238    4.137E-02 0.0033   6.228E-05 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.471E-04 0.0000
======  =========  ======  =========  ======   =========  ======    =========  ======    =========  ======    =========  ======    =========  ======
otal    1.267E+01 0.9960   6.093E-03 0.0005   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.359E-02 0.0034
```

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RESRAD, Version 5.82     T½ Limit = 0.5 year        10/15/99  11:54     Page  20
Summary : SEAD-63 Recreational child - Site Specific Parameters
File    : RECCHILD.RAD

                                Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                                      Water Dependent Pathways

              Water                Fish                 Radon                Plant                Meat                 Milk             All Pathways*
Radio-  -------------------- -------------------- -------------------- -------------------- -------------------- -------------------- --------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- ---------- -------- ---------- -------- ---------- -------- ---------- -------- ---------- -------- ---------- -------- ---------- --------
Ac-227  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 5.301E-01 0.0417
Co-57   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.447E-03 0.0001
Co-60   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.540E+00 0.1996
Cs-137  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 9.126E-01 0.0717
H-3     1.600E-03 0.0001 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.600E-03 0.0001
Pa-231  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.605E-01 0.0126
Pb-210  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 7.386E-03 0.0006
Pu-239  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.589E-03 0.0003
Pu-240  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.544E-03 0.0003
Ra-226  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.377E+00 0.2654
Ra-228  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.768E+00 0.2175
Th-228  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 5.067E-01 0.0398
Th-230  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 8.391E-03 0.0007
Th-232  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.632E+00 0.1282
U-234   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.549E-04 0.0000
U-235   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.319E-01 0.0182
U-238   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.167E-02 0.0033
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
Total   1.600E-03 0.0001 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.273E+01 1.0000

*Sum of all water independent and dependent pathways.
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                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                   As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                         Water Independent Pathways (Inhalation excludes radon)

             Ground            Inhalation            Radon                Plant                Meat                 Milk                 Soil
adio-   -----------------  -----------------  -----------------  -----------------  -----------------  -----------------  -----------------
uclide  mrem/yr    fract.  mrem/yr    fract.  mrem/yr    fract.  mrem/yr    fract.  mrem/yr    fract.  mrem/yr    fract.  mrem/yr    fract.
------- ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------  ---------  ------
c-227   4.334E-01 0.0381  2.521E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.665E-03 0.0009
o-57    1.352E-05 0.0000  4.204E-13 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.520E-11 0.0000
o-60    1.316E+00 0.1157  3.119E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.669E-06 0.0000
s-137   8.128E-01 0.0715  1.343E-08 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.665E-05 0.0000
-3      0.000E+00 0.0000  1.764E-11 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.269E-13 0.0000
a-231   2.219E-01 0.0195  1.625E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.334E-02 0.0012
o-210   1.402E-03 0.0001  8.974E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.894E-03 0.0004
u-239   9.175E-05 0.0000  2.276E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.269E-03 0.0003
u-240   4.743E-05 0.0000  2.274E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.267E-03 0.0003
a-226   3.354E+00 0.2951  7.768E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.991E-03 0.0003
a-228   1.799E+00 0.1582  7.527E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.988E-04 0.0001
h-228   8.276E-02 0.0073  4.890E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.993E-05 0.0000
h-230   1.499E-02 0.0013  1.731E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.157E-04 0.0000
h-232   3.010E+00 0.2648  9.756E-04 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.872E-03 0.0003
-234    1.250E-04 0.0000  6.928E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.585E-04 0.0000
-235    2.303E-01 0.0203  6.480E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.463E-04 0.0000
-238    4.113E-02 0.0036  6.193E-05 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.457E-04 0.0000
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
otal    1.132E+01 0.9956  6.043E-03 0.0005  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.332E-02 0.0038
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                             Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                          As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                            Water Dependent Pathways

             Water              Fish              Radon              Plant              Meat               Milk          All Pathways*
Radio-  ----------------- ----------------- ----------------- ----------------- ----------------- ----------------- -----------------
Nuclide  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------- --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------ --------- ------
Ac-227  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.456E-01 0.0392
Co-57   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.352E-05 0.0000
Co-60   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.316E+00 0.1157
Cs-137  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 8.128E-01 0.0715
H-3     2.155E-04 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.155E-04 0.0000
Pa-231  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.368E-01 0.0208
Pb-210  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 6.305E-03 0.0006
Pu-239  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.588E-03 0.0003
Pu-240  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.541E-03 0.0003
Ra-226  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.357E+00 0.2953
Ra-228  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.799E+00 0.1583
Th-228  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 8.279E-02 0.0073
Th-230  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.568E-02 0.0014
Th-232  0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 3.014E+00 0.2652
U-234   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.528E-04 0.0000
U-235   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 2.306E-01 0.0203
U-238   0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 4.143E-02 0.0036
======= ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ====== ========= ======
Total   2.155E-04 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 1.137E+01 1.0000

*Sum of all water independent and dependent pathways.
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ESRAD, Ver          2      T½ Limit = 0.5 year          10/15/99  11:5          age  23
ummary : SE..      ecreational child - Site Specific Parameters
ile    : RECCh..D.RAD

                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                        Water Independent Pathways (Inhalation excludes radon)

            Ground               Inhalation              Radon                  Plant                  Meat                   Milk                   Soil
adio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
uclide mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------ ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
:-227  2.575E-01 0.0260    1.498E-03 0.0002    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.742E-03 0.0006
>-57   1.104E-11 0.0000    3.430E-19 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.768E-17 0.0000
>-60   1.828E-01 0.0184    4.336E-09 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.269E-07 0.0000
;-137  5.742E-01 0.0579    9.491E-09 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.589E-05 0.0000
·3     0.000E+00 0.0000    1.313E-19 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.689E-21 0.0000
ı-231  3.778E-01 0.0381    2.526E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.667E-02 0.0017
>-210  8.717E-04 0.0001    5.581E-06 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.044E-03 0.0003
ı-239  9.167E-05 0.0000    2.274E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.266E-03 0.0003
ı-240  4.733E-05 0.0000    2.270E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.260E-03 0.0003
ı-226  3.292E+00 0.3319    1.092E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.734E-03 0.0005
ı-228  3.108E-01 0.0313    1.335E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.179E-04 0.0000
ı-228  3.610E-04 0.0000    2.133E-08 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.695E-08 0.0000
ı-230  3.658E-02 0.0037    1.731E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.412E-04 0.0001
ı-232  4.569E+00 0.4607    1.042E-03 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.468E-03 0.0005
 234   1.263E-04 0.0000    6.811E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.541E-04 0.0000
 235   2.264E-01 0.0228    6.435E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.469E-04 0.0000
 238   4.042E-02 0.0041    6.086E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.415E-04 0.0000
====== ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
tal    9.869E+00 0.9951    5.917E-03 0.0006    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.261E-02 0.0043
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ESRAD, Version 5.82     T½ Limit = 0.5 year       10/15/99  11:54     Page  24
ummary : SEAD-63 Recreational child - Site Specific Parameters
ile    : RECCHILD.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                     Water Dependent Pathways

              Water                Fish                Radon                Plant                Meat                 Milk             All Pathways*
adio-    ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
uclide   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
c-227    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.647E-01  0.0267
o-57     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.104E-11  0.0000
o-60     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.828E-01  0.0184
s-137    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.742E-01  0.0579
-3       5.259E-07  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.259E-07  0.0000
a-231    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.970E-01  0.0400
b-210    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.921E-03  0.0004
u-239    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.585E-03  0.0004
u-240    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.534E-03  0.0004
a-226    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.296E+00  0.3324
a-228    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.110E-01  0.0314
h-228    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.611E-04  0.0000
h-230    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.730E-02  0.0038
h-232    0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.574E+00  0.4613
-234     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.486E-04  0.0000
-235     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.267E-01  0.0229
-238     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.072E-02  0.0041
======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
otal     5.259E-07  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   9.917E+00  1.0000
Sum of all water independent and dependent pathways.
```

```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                        Water Independent Pathways (Inhalation excludes radon)

            Ground              Inhalation              Radon                 Plant                 Meat                  Milk                  Soil
adio-   -----------------   -----------------   -----------------   -----------------   -----------------   -----------------   -----------------
uclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
c-227   1.530E-01  0.0161   8.900E-04  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.411E-03  0.0004
o-57    9.004E-18  0.0000   2.799E-25  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.338E-23  0.0000
o-60    2.541E-02  0.0027   6.026E-10  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.288E-07  0.0000
s-137   4.057E-01  0.0426   6.705E-09  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.829E-05  0.0000
-3      0.000E+00  0.0000   9.665E-28  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.244E-29  0.0000
a-231   4.661E-01  0.0489   3.034E-03  0.0003   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.849E-02  0.0019
b-210   5.421E-04  0.0001   3.471E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.893E-03  0.0002
u-239   9.159E-05  0.0000   2.272E-04  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.263E-03  0.0003
u-240   4.723E-05  0.0000   2.265E-04  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.253E-03  0.0003
a-226   3.230E+00  0.3391   1.277E-05  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.763E-03  0.0006
a-228   5.042E-02  0.0053   2.166E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.911E-05  0.0000
h-228   1.575E-06  0.0000   9.305E-11  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.793E-10  0.0000
h-230   5.777E-02  0.0061   1.732E-04  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.755E-04  0.0001
h-232   4.828E+00  0.5067   1.053E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.566E-03  0.0005
-234    1.305E-04  0.0000   6.696E-05  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.498E-04  0.0000
-235    2.226E-01  0.0234   6.413E-05  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.482E-04  0.0000
-238    3.973E-02  0.0042   5.982E-05  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.374E-04  0.0000
======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
otal    9.480E+00  0.9950   5.814E-03  0.0006   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.199E-02  0.0044
```

```
                      Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                   As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                                    Water Dependent Pathways

            Water               Fish               Radon               Plant               Meat               Milk            All Pathways*
adio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
uclide mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.  mrem/yr   fract.
------ --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
c-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.573E-01 0.0165
o-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.004E-18 0.0000
o-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.541E-02 0.0027
s-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.057E-01 0.0426
-3     1.283E-09 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.283E-09 0.0000
a-231  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.876E-01 0.0512
b-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.439E-03 0.0003
u-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.582E-03 0.0004
u-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.527E-03 0.0004
a-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.236E+00 0.3397
a-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.044E-02 0.0053
h-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.575E-06 0.0000
h-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.851E-02 0.0061
h-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.833E+00 0.5073
-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.473E-04 0.0000
-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.230E-01 0.0234
-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.002E-02 0.0042
====== ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
otal   1.283E-09 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.527E+00 1.0000

Sum of all water independent and dependent pathways.
```

```
                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                   Water Independent Pathways (Inhalation excludes radon)

           Ground            Inhalation             Radon               Plant                Meat                Milk                Soil
adio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
iclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------ --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
-227   9.089E-02 0.0097    5.287E-04 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.027E-03 0.0002
-57    7.346E-24 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.171E-29 0.0000
-60    3.532E-03 0.0004    8.375E-11 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.790E-08 0.0000
-137   2.866E-01 0.0307    4.737E-09 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.292E-05 0.0000
-3     0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000
-231   5.143E-01 0.0551    3.309E-03 0.0004    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.942E-02 0.0021
-210   3.372E-04 0.0000    2.159E-06 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.177E-03 0.0001
-239   9.152E-05 0.0000    2.270E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.261E-03 0.0003
-240   4.714E-05 0.0000    2.261E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.247E-03 0.0003
-226   3.170E+00 0.3399    1.380E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.351E-03 0.0007
-228   8.165E-03 0.0009    3.508E-07 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.094E-06 0.0000
-228   6.870E-09 0.0000    4.059E-13 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.655E-12 0.0000
-230   7.855E-02 0.0084    1.732E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.149E-04 0.0001
-232   4.870E+00 0.5221    1.055E-03 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.582E-03 0.0005
234    1.374E-04 0.0000    6.583E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.456E-04 0.0000
235    2.190E-01 0.0235    6.403E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.499E-04 0.0000
238    3.904E-02 0.0042    5.879E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.333E-04 0.0000
====== ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
tal    9.280E+00 0.9949    5.724E-03 0.0006    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.143E-02 0.0044
```

```
               Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                             As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                  Water Dependent Pathways

              Water                 Fish                 Radon                 Plant                 Meat                  Milk              All Pathways*
.adio-  ---------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
'uclide  mrem/yr    fract.      mrem/yr   fract.      mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
------  ---------- --------  ---------- --------  ---------- --------  ---------- --------  ---------- --------  ---------- --------  ---------- --------
.c-227  0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    9.345E-02  0.0100
'o-57   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    7.347E-24  0.0000
'o-60   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.532E-03  0.0004
s-137   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    2.866E-01  0.0307
-3      3.132E-12  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.132E-12  0.0000
'a-231  0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    5.371E-01  0.0576
b-210   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.517E-03  0.0002
'u-239  0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.579E-03  0.0004
u-240   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.520E-03  0.0004
a-226   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.176E+00  0.3405
a-228   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    8.168E-03  0.0009
h-228   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    6.872E-09  0.0000
h-230   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    7.934E-02  0.0085
h-232   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    4.875E+00  0.5227
-234    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    4.488E-04  0.0000
-235    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    2.193E-01  0.0235
-238    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.933E-02  0.0042
======  ========== ========  ========== ========  ========== ========  ========== ========  ========== ========  ========== ========  ========== ========
otal    3.132E-12  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    9.328E+00  1.0000
Sum of all water independent and dependent pathways.
```

```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                         Water Independent Pathways (Inhalation excludes radon)

              Ground            Inhalation            Radon              Plant               Meat                Milk                Soil
Radio-   ----------------- ------------------ ------------------ ------------------ ------------------ ------------------ ------------------
Nuclide  mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.   mrem/yr   fract.
-------  --------- ------  --------- ------   --------- ------   --------- ------   --------- ------   --------- ------   --------- ------
Ac-227   5.400E-02 0.0059  3.141E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.204E-03 0.0001
Co-57    5.994E-30 0.0000  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000
Co-60    4.909E-04 0.0001  1.164E-11 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.488E-09 0.0000
Cs-137   2.025E-01 0.0220  3.347E-09 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   9.130E-06 0.0000
H-3      0.000E+00 0.0000  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000
Pa-231   5.389E-01 0.0587  3.446E-03 0.0004   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.983E-02 0.0022
Pb-210   2.097E-04 0.0000  1.343E-06 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   7.323E-04 0.0001
Pu-239   9.144E-05 0.0000  2.268E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.258E-03 0.0004
Pu-240   4.704E-05 0.0000  2.256E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.240E-03 0.0004
Ra-226   3.111E+00 0.3387  1.434E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.665E-03 0.0007
Ra-228   1.322E-03 0.0001  5.680E-08 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   5.011E-07 0.0000
Th-228   2.997E-11 0.0000  1.771E-15 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   7.218E-15 0.0000
Th-230   9.894E-02 0.0108  1.733E-04 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.573E-04 0.0001
Th-232   4.876E+00 0.5310  1.055E-03 0.0001   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.585E-03 0.0005
U-234    1.469E-04 0.0000  6.472E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.415E-04 0.0000
U-235    2.154E-01 0.0235  6.399E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.518E-04 0.0000
U-238    3.837E-02 0.0042  5.779E-05 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.293E-04 0.0000
=======  ========= ======  ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
 otal    9.138E+00 0.9949  5.644E-03 0.0006   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.091E-02 0.0045
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ESRAD, Version 5.82     T½ Limit = 0.5 year        10/15/99  11:54     Page  30
ummary : SEAD-63 Recreational child - Site Specific Parameters
ile    : RECCHILD.RAD

                     Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                    Water Dependent Pathways

            Water                Fish                 Radon                Plant                 Meat                 Milk             All Pathways*
adio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
uclide  mrem/yr    fract.    mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
------ ---------- -------  ---------- -------   ---------- -------   ---------- -------   ---------- -------   ---------- -------   ---------- -------
c-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.552E-02 0.0060
o-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.994E-30 0.0000
o-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.909E-04 0.0001
s-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.025E-01 0.0220
-3     7.644E-15 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.644E-15 0.0000
a-231  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.621E-01 0.0612
o-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.433E-04 0.0001
u-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.576E-03 0.0004
u-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.513E-03 0.0004
a-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.117E+00 0.3394
a-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.323E-03 0.0001
h-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.998E-11 0.0000
h-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.977E-02 0.0109
h-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.882E+00 0.5316
-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.531E-04 0.0000
-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.157E-01 0.0235
-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.866E-02 0.0042
====== ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
otal   7.644E-15 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.184E+00 1.0000

Sum of all water independent and dependent pathways.
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                         Dose/Source Ratios Summed Over All Pathways
                 Parent and Progeny Principal Radionuclide Contributions Indicated

arent   Product  Branch                              DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)      (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
______  _______  _________    _________ _________ _________ _________ _________ _________ _________ _________
c-227   Ac-227   1.000E+00    6.305E-01 6.090E-01 5.301E-01 4.456E-01 2.647E-01 1.573E-01 9.345E-02 5.552E-02

o-57    Co-57    1.000E+00    1.549E-01 6.083E-02 1.447E-03 1.352E-05 1.104E-11 9.004E-18 7.347E-24 5.994E-30

o-60    Co-60    1.000E+00    4.903E+00 4.299E+00 2.540E+00 1.316E+00 1.828E-01 2.541E-02 3.532E-03 4.909E-04

s-137   Cs-137   1.000E+00    1.025E+00 1.001E+00 9.126E-01 8.128E-01 5.742E-01 4.057E-01 2.866E-01 2.025E-01

-3      H-3      1.000E+00    4.655E-06 4.945E-04 1.600E-03 2.155E-04 5.259E-07 1.283E-09 3.132E-12 7.644E-15

-231    Pa-231   1.000E+00    6.908E-02 6.900E-02 6.868E-02 6.827E-02 6.708E-02 6.591E-02 6.475E-02 6.362E-02
-231    Ac-227   1.000E+00    0.000E+00 1.972E-02 9.186E-02 1.685E-01 3.299E-01 4.217E-01 4.723E-01 4.985E-01
-231    ∑DSR(j)               6.908E-02 8.872E-02 1.605E-01 2.368E-01 3.970E-01 4.876E-01 5.371E-01 5.621E-01

-210    Pb-210   1.000E+00    8.653E-03 8.384E-03 7.386E-03 6.305E-03 3.921E-03 2.439E-03 1.517E-03 9.433E-04

-239    Pu-239   1.000E+00    3.591E-03 3.590E-03 3.589E-03 3.588E-03 3.585E-03 3.582E-03 3.579E-03 3.576E-03
-239    U-235    1.000E+00    0.000E+00 2.296E-10 1.145E-09 2.283E-09 5.656E-09 8.968E-09 1.222E-08 1.541E-08
-239    Pa-231   1.000E+00    0.000E+00 7.192E-16 1.792E-14 7.141E-14 4.410E-13 1.116E-12 2.084E-12 3.336E-12
-239    Ac-227   1.000E+00    0.000E+00 6.907E-17 8.323E-15 6.367E-14 8.750E-13 3.179E-12 7.385E-12 1.370E-11
-239    ∑DSR(j)               3.591E-03 3.590E-03 3.589E-03 3.588E-03 3.585E-03 3.582E-03 3.579E-03 3.576E-03

-240    Pu-240   1.000E+00    3.546E-03 3.546E-03 3.544E-03 3.541E-03 3.534E-03 3.527E-03 3.520E-03 3.513E-03
-240    U-236    1.000E+00    0.000E+00 1.132E-11 5.647E-11 1.126E-10 2.787E-10 4.417E-10 6.015E-10 7.582E-10
-240    Th-232   1.000E+00    0.000E+00 2.595E-21 6.477E-20 2.585E-19 1.605E-18 4.083E-18 7.671E-18 1.235E-17
-240    Ra-228   1.000E+00    0.000E+00 5.160E-20 5.741E-18 4.016E-17 4.460E-16 1.393E-15 2.902E-15 4.967E-15
-240    Th-228   1.000E+00    0.000E+00 7.492E-21 3.295E-18 3.599E-17 5.837E-16 2.029E-15 4.433E-15 7.791E-15
-240    ∑DSR(j)               3.546E-03 3.546E-03 3.544E-03 3.541E-03 3.534E-03 3.527E-03 3.520E-03 3.513E-03

 -226   Ra-226   1.000E+00    3.397E+00 3.393E+00 3.376E+00 3.355E+00 3.292E+00 3.230E+00 3.170E+00 3.110E+00
 -226   Pb-210   1.000E+00    0.000E+00 2.646E-04 1.240E-03 2.290E-03 4.564E-03 5.919E-03 6.704E-03 7.136E-03
 -226   ∑DSR(j)               3.397E+00 3.393E+00 3.377E+00 3.357E+00 3.296E+00 3.236E+00 3.176E+00 3.117E+00

 -228   Ra-228   1.000E+00    1.813E+00 1.606E+00 9.880E-01 5.385E-01 8.720E-02 1.412E-02 2.287E-03 3.702E-04
 -228   Th-228   1.000E+00    0.000E+00 8.843E-01 1.780E+00 1.261E+00 2.238E-01 3.632E-02 5.882E-03 9.524E-04
 -228   ∑DSR(j)               1.813E+00 2.490E+00 2.768E+00 1.799E+00 3.110E-01 5.044E-02 8.168E-03 1.323E-03

 -228   Th-228   1.000E+00    3.101E+00 2.158E+00 5.067E-01 8.279E-02 3.611E-04 1.575E-06 6.872E-09 2.998E-11

 -230   Th-230   1.000E+00    1.055E-03 1.055E-03 1.055E-03 1.055E-03 1.054E-03 1.054E-03 1.054E-03 1.054E-03
 -230   Ra-226   1.000E+00    0.000E+00 1.471E-03 7.335E-03 1.462E-02 3.621E-02 5.740E-02 7.818E-02 9.857E-02
 -230   Pb-210   1.000E+00    0.000E+00 5.763E-08 1.380E-06 5.234E-06 2.812E-05 6.257E-05 1.038E-04 1.489E-04
 -230   ∑DSR(j)               1.055E-03 2.525E-03 8.391E-03 1.568E-02 3.730E-02 5.851E-02 7.934E-02 9.977E-02
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                             Dose/Source Ratios Summed Over All Pathways
                   Parent and Progeny Principal Radionuclide Contributions Indicated

arent  Product  Branch                                     DSR(j,t)  (mrem/yr)/(pCi/g)
(i)      (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_____  _______  _________    _________ _________ _________ _________ _________ _________ _________ _________
h-232  Th-232   1.000E+00    3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03
h-232  Ra-228   1.000E+00    0.000E+00 2.058E-01 8.191E-01 1.266E+00 1.714E+00 1.786E+00 1.798E+00 1.800E+00
h-232  Th-228   1.000E+00    0.000E+00 5.780E-02 8.090E-01 1.745E+00 2.857E+00 3.044E+00 3.074E+00 3.079E+00
h-232  ∑DSR(j)               3.555E-03 2.671E-01 1.632E+00 3.014E+00 4.574E+00 4.833E+00 4.875E+00 4.882E+00

-234   U-234    1.000E+00    4.574E-04 4.568E-04 4.547E-04 4.521E-04 4.443E-04 4.366E-04 4.291E-04 4.217E-04
-234   Th-230   1.000E+00    0.000E+00 9.489E-09 4.733E-08 9.439E-08 2.339E-07 3.710E-07 5.057E-07 6.381E-07
-234   Ra-226   1.000E+00    0.000E+00 6.619E-09 1.649E-07 6.571E-07 4.057E-06 1.026E-05 1.917E-05 3.068E-05
-234   Pb-210   1.000E+00    0.000E+00 1.733E-13 2.095E-11 1.608E-10 2.231E-09 8.172E-09 1.912E-08 3.568E-08
-234   ∑DSR(j)               4.574E-04 4.569E-04 4.549E-04 4.528E-04 4.486E-04 4.473E-04 4.488E-04 4.531E-04

-235   U-235    1.000E+00    2.332E-01 2.330E-01 2.319E-01 2.305E-01 2.266E-01 2.227E-01 2.189E-01 2.151E-01
-235   Pa-231   1.000E+00    0.000E+00 1.460E-06 7.266E-06 1.445E-05 3.549E-05 5.580E-05 7.540E-05 9.429E-05
-235   Ac-227   1.000E+00    0.000E+00 2.097E-07 4.995E-06 1.883E-05 9.932E-05 2.173E-04 3.550E-04 5.022E-04
-235   ∑DSR(j)               2.332E-01 2.330E-01 2.319E-01 2.306E-01 2.267E-01 2.230E-01 2.193E-01 2.157E-01

-238   U-238    1.000E+00    4.192E-02 4.187E-02 4.167E-02 4.143E-02 4.072E-02 4.002E-02 3.933E-02 3.866E-02
-238   U-234    1.000E+00    0.000E+00 1.295E-09 6.446E-09 1.282E-08 3.149E-08 4.952E-08 6.692E-08 8.370E-08
-238   Th-230   1.000E+00    0.000E+00 1.345E-14 3.351E-13 1.335E-12 8.250E-12 2.088E-11 3.902E-11 6.247E-11
-238   Ra-226   1.000E+00    0.000E+00 6.264E-15 7.789E-13 6.204E-12 9.564E-11 3.865E-10 9.914E-10 2.017E-09
-238   Pb-210   1.000E+00    0.000E+00 1.446E-19 7.480E-17 1.156E-15 4.089E-14 2.438E-13 7.966E-13 1.919E-12
-238   ∑DSR(j)               4.192E-02 4.187E-02 4.167E-02 4.143E-02 4.072E-02 4.002E-02 3.933E-02 3.866E-02
=====  =======  =========    ========= ========= ========= ========= ========= ========= ========= =========
Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
he DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.
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                              Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                                   Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)     t= 0.000E+00    1.000E+00    5.000E+00    1.000E+01    2.500E+01    4.000E+01    5.500E+01    7.000E+01
_______      _________    _________    _________    _________    _________    _________    _________    _________
Ac-227       1.586E+01    1.642E+01    1.887E+01    2.244E+01    3.777E+01    6.358E+01    1.070E+02    1.801E+02
Co-57        6.456E+01    1.644E+02    6.909E+03    7.394E+05    9.062E+11   *8.464E+15   *8.464E+15   *8.464E+15
Co-60        2.040E+00    2.326E+00    3.937E+00    7.601E+00    5.469E+01    3.935E+02    2.831E+03    2.037E+04
Cs-137       9.759E+00    9.988E+00    1.096E+01    1.230E+01    1.741E+01    2.465E+01    3.489E+01    4.938E+01
H-3          2.148E+06    2.022E+04    6.248E+03    4.641E+04    1.902E+07    7.792E+09    3.193E+12    1.308E+15
Pa-231       1.448E+02    1.127E+02    6.229E+01    4.223E+01    2.519E+01    2.051E+01    1.862E+01    1.779E+01
Pb-210       1.156E+03    1.193E+03    1.354E+03    1.586E+03    2.550E+03    4.100E+03    6.593E+03    1.060E+04
Pu-239       2.785E+03    2.785E+03    2.786E+03    2.787E+03    2.789E+03    2.792E+03    2.794E+03    2.796E+03
Pu-240       2.820E+03    2.820E+03    2.822E+03    2.824E+03    2.829E+03    2.835E+03    2.841E+03    2.847E+03
Ra-226       2.944E+00    2.947E+00    2.961E+00    2.979E+00    3.034E+00    3.090E+00    3.148E+00    3.208E+00
Ra-228       5.517E+00    4.016E+00    3.613E+00    5.558E+00    3.216E+01    1.983E+02    1.224E+03    7.561E+03
Th-228       3.225E+00    4.633E+00    1.974E+01    1.208E+02    2.769E+04    6.348E+06    1.455E+09    3.336E+11
Th-230       9.481E+03    3.960E+03    1.192E+03    6.376E+02    2.681E+02    1.709E+02    1.260E+02    1.002E+02
Th-232       2.813E+03    3.743E+01    6.129E+00    3.317E+00    2.186E+00    2.069E+00    2.051E+00    2.048E+00
J-234        2.186E+04    2.189E+04    2.198E+04    2.208E+04    2.229E+04    2.236E+04    2.228E+04    2.207E+04
J-235        4.288E+01    4.293E+01    4.312E+01    4.337E+01    4.411E+01    4.485E+01    4.560E+01    4.636E+01
J-238        2.386E+02    2.388E+02    2.400E+02    2.413E+02    2.456E+02    2.499E+02    2.542E+02    2.587E+02
_______      _________    _________    _________    _________    _________    _________    _________    _________
*At specific activity limit


                   Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
                   and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
               at tmin = time of minimum single radionuclide soil guideline
          and at tmax = time of maximum total dose = 0.000E+00 years

uclide   Initial           tmin          DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
 (i)      pCi/g           (years)                     (pCi/g)               (pCi/g)
_______  _________   ________________    _________   _________  _________   _________
c-227    1.000E+00       0.000E+00        6.305E-01   1.586E+01  6.305E-01   1.586E+01
o-57     1.000E+00       0.000E+00        1.549E-01   6.456E+01  1.549E-01   6.456E+01
o-60     1.000E+00       0.000E+00        4.903E+00   2.040E+00  4.903E+00   2.040E+00
s-137    1.000E+00       0.000E+00        1.025E+00   9.759E+00  1.025E+00   9.759E+00
-3       1.000E+00     3.700 ± 0.007      2.687E-03   3.721E+03  4.655E-06   2.148E+06
a-231    1.000E+00       7.000E+01        5.621E-01   1.779E+01  6.908E-02   1.448E+02
b-210    1.000E+00       0.000E+00        8.653E-03   1.156E+03  8.653E-03   1.156E+03
u-239    1.000E+00       0.000E+00        3.591E-03   2.785E+03  3.591E-03   2.785E+03
u-240    1.000E+00       0.000E+00        3.546E-03   2.820E+03  3.546E-03   2.820E+03
a-226    1.000E+00       0.000E+00        3.397E+00   2.944E+00  3.397E+00   2.944E+00
a-228    1.000E+00     3.177 ± 0.006      2.929E+00   3.414E+00  1.813E+00   5.517E+00
h-228    1.000E+00       0.000E+00        3.101E+00   3.225E+00  3.101E+00   3.225E+00
h-230    1.000E+00       7.000E+01        9.977E-02   1.002E+02  1.055E-03   9.481E+03
h-232    1.000E+00       7.000E+01        4.882E+00   2.048E+00  3.555E-03   2.813E+03
-234     1.000E+00       0.000E+00        4.574E-04   2.186E+04  4.574E-04   2.186E+04
-235     1.000E+00       0.000E+00        2.332E-01   4.288E+01  2.332E-01   4.288E+01
-238     1.000E+00       0.000E+00        4.192E-02   2.386E+02  4.192E-02   2.386E+02
_______  _________   ________________    _________   _________  _________   _________
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                                      Individual Nuclide Dose Summed Over All Pathways
                                        Parent Nuclide and Branch Fraction Indicated

Nuclide Parent    BRF(i)                                          DOSE(j,t), mrem/yr
  (j)     (i)                t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
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\c-227  Ac-227   1.000E+00      6.305E-01 6.090E-01 5.301E-01 4.456E-01 2.647E-01 1.573E-01 9.345E-02 5.552E-02
\c-227  Pa-231   1.000E+00      0.000E+00 1.972E-02 9.186E-02 1.685E-01 3.299E-01 4.217E-01 4.723E-01 4.985E-01
\c-227  Pu-239   1.000E+00      0.000E+00 6.907E-17 8.323E-15 6.367E-14 8.750E-13 3.179E-12 7.385E-12 1.370E-11
\c-227  U-235    1.000E+00      0.000E+00 2.097E-07 4.995E-06 1.883E-05 9.932E-05 2.173E-04 3.550E-04 5.022E-04
\c-227  ∑DOSE(j):               6.305E-01 6.287E-01 6.219E-01 6.142E-01 5.947E-01 5.792E-01 5.661E-01 5.545E-01

:o-57   Co-57    1.000E+00      1.549E-01 6.083E-02 1.447E-03 1.352E-05 1.104E-11 9.004E-18 7.347E-24 5.994E-30

:o-60   Co-60    1.000E+00      4.903E+00 4.299E+00 2.540E+00 1.316E+00 1.828E-01 2.541E-02 3.532E-03 4.909E-04

:s-137  Cs-137   1.000E+00      1.025E+00 1.001E+00 9.126E-01 8.128E-01 5.742E-01 4.057E-01 2.866E-01 2.025E-01

I-3     H-3      1.000E+00      4.655E-06 4.945E-04 1.600E-03 2.155E-04 5.259E-07 1.283E-09 3.132E-12 7.644E-15

'a-231  Pa-231   1.000E+00      6.908E-02 6.900E-02 6.868E-02 6.827E-02 6.708E-02 6.591E-02 6.475E-02 6.362E-02
'a-231  Pu-239   1.000E+00      0.000E+00 7.192E-16 1.792E-14 7.141E-14 4.410E-13 1.116E-12 2.084E-12 3.336E-12
'a-231  U-235    1.000E+00      0.000E+00 1.460E-06 7.266E-06 1.445E-05 3.549E-05 5.580E-05 7.540E-05 9.429E-05
'a-231  ∑DOSE(j):               6.908E-02 6.900E-02 6.869E-02 6.829E-02 6.712E-02 6.596E-02 6.483E-02 6.371E-02

'b-210  Pb-210   1.000E+00      8.653E-03 8.384E-03 7.386E-03 6.305E-03 3.921E-03 2.439E-03 1.517E-03 9.433E-04
'b-210  Ra-226   1.000E+00      0.000E+00 2.646E-04 1.240E-03 2.290E-03 4.564E-03 5.919E-03 6.704E-03 7.136E-03
'b-210  Th-230   1.000E+00      0.000E+00 5.763E-08 1.380E-06 5.234E-06 2.812E-05 6.257E-05 1.038E-04 1.489E-04
'b-210  U-234    1.000E+00      0.000E+00 1.733E-13 2.095E-11 1.608E-10 2.231E-09 8.172E-09 1.912E-08 3.568E-08
'b-210  U-238    1.000E+00      0.000E+00 1.446E-19 7.480E-17 1.156E-15 4.089E-14 2.438E-13 7.966E-13 1.919E-12
'b-210  ∑DOSE(j):               8.653E-03 8.648E-03 8.628E-03 8.601E-03 8.513E-03 8.420E-03 8.325E-03 8.228E-03

'u-239  Pu-239   1.000E+00      3.591E-03 3.590E-03 3.589E-03 3.588E-03 3.585E-03 3.582E-03 3.579E-03 3.576E-03

J-235   Pu-239   1.000E+00      0.000E+00 2.296E-10 1.145E-09 2.283E-09 5.656E-09 8.968E-09 1.222E-08 1.541E-08
J-235   U-235    1.000E+00      2.332E-01 2.330E-01 2.319E-01 2.305E-01 2.266E-01 2.227E-01 2.189E-01 2.151E-01
J-235   ∑DOSE(j):               2.332E-01 2.330E-01 2.319E-01 2.305E-01 2.266E-01 2.227E-01 2.189E-01 2.151E-01

'u-240  Pu-240   1.000E+00      3.546E-03 3.546E-03 3.544E-03 3.541E-03 3.534E-03 3.527E-03 3.520E-03 3.513E-03

J-236   Pu-240   1.000E+00      0.000E+00 1.132E-11 5.647E-11 1.126E-10 2.787E-10 4.417E-10 6.015E-10 7.582E-10

'h-232  Pu-240   1.000E+00      0.000E+00 2.595E-21 6.477E-20 2.585E-19 1.605E-18 4.083E-18 7.671E-18 1.235E-17
'h-232  Th-232   1.000E+00      3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03
'h-232  ∑DOSE(j):               3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03 3.555E-03

ta-228  Pu-240   1.000E+00      0.000E+00 5.160E-20 5.741E-18 4.016E-17 4.460E-16 1.393E-15 2.902E-15 4.967E-15
ta-228  Ra-228   1.000E+00      1.813E+00 1.606E+00 9.880E-01 5.385E-01 8.720E-02 1.412E-02 2.287E-03 3.702E-04
ta-228  Th-232   1.000E+00      0.000E+00 2.058E-01 8.191E-01 1.266E+00 1.714E+00 1.786E+00 1.798E+00 1.800E+00
ta-228  ∑DOSE(j):               1.813E+00 1.811E+00 1.807E+00 1.804E+00 1.801E+00 1.800E+00 1.800E+00 1.800E+00

'h-228  Pu-240   1.000E+00      0.000E+00 7.492E-21 3.295E-18 3.599E-17 5.837E-16 2.029E-15 4.433E-15 7.791E-15
'h-228  Ra-228   1.000E+00      0.000E+00 8.843E-01 1.780E+00 1.261E+00 2.238E-01 3.632E-02 5.882E-03 9.524E-04
'h-228  Th-228   1.000E+00      3.101E+00 2.158E+00 5.067E-01 8.279E-02 3.611E-04 1.575E-06 6.872E-09 2.998E-11
'h-228  Th-232   1.000E+00      0.000E+00 5.780E-02 8.090E-01 1.745E+00 2.857E+00 3.044E+00 3.074E+00 3.079E+00
'h-228  ∑DOSE(j):               3.101E+00 3.100E+00 3.095E+00 3.089E+00 3.081E+00 3.080E+00 3.080E+00 3.080E+00
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                         Individual Nuclide Dose Summed Over All Pathways
                           Parent Nuclide and Branch Fraction Indicated

Nuclide Parent  BRF(i)                                  DOSE(j,t), mrem/yr
  (j)     (i)             t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ _______ _________    _________ _________ _________ _________ _________ _________ _________ _________

Ra-226  Ra-226  1.000E+00    3.397E+00 3.393E+00 3.376E+00 3.355E+00 3.292E+00 3.230E+00 3.170E+00 3.110E+00
Ra-226  Th-230  1.000E+00    0.000E+00 1.471E-03 7.335E-03 1.462E-02 3.621E-02 5.740E-02 7.818E-02 9.857E-02
Ra-226  U-234   1.000E+00    0.000E+00 6.619E-09 1.649E-07 6.571E-07 4.057E-06 1.026E-05 1.917E-05 3.068E-05
Ra-226  U-238   1.000E+00    0.000E+00 6.264E-15 7.789E-13 6.204E-12 9.564E-11 3.865E-10 9.914E-10 2.017E-09
Ra-226  ∑DOSE(j):            3.397E+00 3.394E+00 3.383E+00 3.369E+00 3.328E+00 3.288E+00 3.248E+00 3.209E+00

Th-230  Th-230  1.000E+00    1.055E-03 1.055E-03 1.055E-03 1.055E-03 1.054E-03 1.054E-03 1.054E-03 1.054E-03
Th-230  U-234   1.000E+00    0.000E+00 9.489E-09 4.733E-08 9.439E-08 2.339E-07 3.710E-07 5.057E-07 6.381E-07
Th-230  U-238   1.000E+00    0.000E+00 1.345E-14 3.351E-13 1.335E-12 8.250E-12 2.088E-11 3.902E-11 6.247E-11
Th-230  ∑DOSE(j):            1.055E-03 1.055E-03 1.055E-03 1.055E-03 1.055E-03 1.055E-03 1.055E-03 1.055E-03

U-234   U-234   1.000E+00    4.574E-04 4.568E-04 4.547E-04 4.521E-04 4.443E-04 4.366E-04 4.291E-04 4.217E-04
J-234   U-238   1.000E+00    0.000E+00 1.295E-09 6.446E-09 1.282E-08 3.149E-08 4.952E-08 6.692E-08 8.370E-08
J-234   ∑DOSE(j):            4.574E-04 4.568E-04 4.547E-04 4.521E-04 4.443E-04 4.367E-04 4.292E-04 4.218E-04

J-238   U-238   1.000E+00    4.192E-02 4.187E-02 4.167E-02 4.143E-02 4.072E-02 4.002E-02 3.933E-02 3.866E-02
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3RF(i) is the branch fraction of the parent nuclide.
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                                       Individual Nuclide Soil Concentration
                                    Parent Nuclide and Branch Fraction Indicated

Nuclide Parent    BRF(i)                                        S(j,t), pCi/g
  (j)     (i)              t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ _______ _________     _________ _________ _________ _________ _________ _________ _________ _________

Ac-227  Ac-227  1.000E+00     1.000E+00 9.659E-01 8.407E-01 7.067E-01 4.199E-01 2.495E-01 1.482E-01 8.806E-02
Ac-227  Pa-231  1.000E+00     0.000E+00 3.127E-02 1.457E-01 2.673E-01 5.232E-01 6.689E-01 7.491E-01 7.907E-01
Ac-227  Pu-239  1.000E+00     0.000E+00 1.095E-16 1.320E-14 1.010E-13 1.388E-12 5.041E-12 1.171E-11 2.173E-11
Ac-227  U-235   1.000E+00     0.000E+00 3.327E-07 7.922E-06 2.986E-05 1.575E-04 3.446E-04 5.631E-04 7.964E-04
Ac-227  ∑S(j):                1.000E+00 9.972E-01 9.864E-01 9.741E-01 9.432E-01 9.187E-01 8.979E-01 8.795E-01

Co-57   Co-57   1.000E+00     1.000E+00 3.927E-01 9.344E-03 8.732E-05 7.124E-11 5.813E-17 4.743E-23 3.870E-29

Co-60   Co-60   1.000E+00     1.000E+00 8.767E-01 5.180E-01 2.683E-01 3.729E-02 5.183E-03 7.203E-04 1.001E-04

Cs-137  Cs-137  1.000E+00     1.000E+00 9.771E-01 8.906E-01 7.932E-01 5.604E-01 3.959E-01 2.797E-01 1.976E-01

H-3     H-3     1.000E+00     1.000E+00 2.874E-01 1.960E-03 3.837E-06 2.857E-14 2.103E-22 1.530E-30 1.101E-38

Pa-231  Pa-231  1.000E+00     1.000E+00 9.988E-01 9.941E-01 9.883E-01 9.710E-01 9.540E-01 9.373E-01 9.209E-01
Pa-231  Pu-239  1.000E+00     0.000E+00 1.041E-14 2.594E-13 1.034E-12 6.384E-12 1.615E-11 3.017E-11 4.829E-11
Pa-231  U-235   1.000E+00     0.000E+00 2.113E-05 1.052E-04 2.091E-04 5.138E-04 8.077E-04 1.091E-03 1.365E-03
Pa-231  ∑S(j):                1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01

Pb-210  Pb-210  1.000E+00     1.000E+00 9.688E-01 8.536E-01 7.286E-01 4.531E-01 2.818E-01 1.753E-01 1.090E-01
Pb-210  Ra-226  1.000E+00     0.000E+00 3.058E-02 1.433E-01 2.647E-01 5.274E-01 6.840E-01 7.748E-01 8.246E-01
Pb-210  Th-230  1.000E+00     0.000E+00 6.659E-06 1.594E-04 6.049E-04 3.250E-03 7.230E-03 1.200E-02 1.721E-02
Pb-210  U-234   1.000E+00     0.000E+00 2.003E-11 2.421E-09 1.858E-08 2.578E-07 9.443E-07 2.209E-06 4.123E-06
Pb-210  U-238   1.000E+00     0.000E+00 1.671E-17 8.644E-15 1.336E-13 4.725E-12 2.818E-11 9.206E-11 2.217E-10
Pb-210  ∑S(j):                1.000E+00 9.994E-01 9.970E-01 9.939E-01 9.838E-01 9.731E-01 9.620E-01 9.509E-01

Pu-239  Pu-239  1.000E+00     1.000E+00 9.999E-01 9.997E-01 9.994E-01 9.986E-01 9.977E-01 9.968E-01 9.960E-01

U-235   Pu-239  1.000E+00     0.000E+00 9.843E-10 4.909E-09 9.789E-09 2.425E-08 3.845E-08 5.240E-08 6.609E-08
U-235   U-235   1.000E+00     1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01
U-235   ∑S(j):                1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01

Pu-240  Pu-240  1.000E+00     1.000E+00 9.999E-01 9.993E-01 9.987E-01 9.966E-01 9.946E-01 9.926E-01 9.906E-01

U-236   Pu-240  1.000E+00     0.000E+00 2.958E-08 1.475E-07 2.941E-07 7.282E-07 1.154E-06 1.572E-06 1.981E-06

Th-232  Pu-240  1.000E+00     0.000E+00 7.299E-19 1.822E-17 7.271E-17 4.515E-16 1.148E-15 2.157E-15 3.472E-15
Th-232  Th-232  1.000E+00     1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01
Th-232  ∑S(j):                1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01

Ra-228  Pu-240  1.000E+00     0.000E+00 2.846E-20 3.167E-18 2.215E-17 2.460E-16 7.685E-16 1.601E-15 2.740E-15
Ra-228  Ra-228  1.000E+00     1.000E+00 8.857E-01 5.451E-01 2.971E-01 4.811E-02 7.790E-03 1.261E-03 2.042E-04
Ra-228  Th-232  1.000E+00     0.000E+00 1.135E-01 4.518E-01 6.981E-01 9.454E-01 9.854E-01 9.919E-01 9.929E-01
Ra-228  ∑S(j):                1.000E+00 9.992E-01 9.969E-01 9.952E-01 9.935E-01 9.932E-01 9.932E-01 9.931E-01

Th-228  Pu-240  1.000E+00     0.000E+00 2.416E-21 1.063E-18 1.161E-17 1.882E-16 6.543E-16 1.430E-15 2.513E-15
Th-228  Ra-228  1.000E+00     0.000E+00 2.852E-01 5.739E-01 4.066E-01 7.216E-02 1.171E-02 1.897E-03 3.071E-04
Th-228  Th-228  1.000E+00     1.000E+00 6.961E-01 1.634E-01 2.670E-02 1.165E-04 5.080E-07 2.216E-09 9.668E-12
Th-228  Th-232  1.000E+00     0.000E+00 1.864E-02 2.609E-01 5.628E-01 9.214E-01 9.815E-01 9.913E-01 9.928E-01
Th-228  ∑S(j):                1.000E+00 9.999E-01 9.982E-01 9.961E-01 9.937E-01 9.932E-01 9.932E-01 9.931E-01
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                                   Individual Nuclide Soil Concentration
                                 Parent Nuclide and Branch Fraction Indicated

Nuclide Parent   BRF(i)                                            S(j,t), pCi/g
  (j)    (i)                 t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ ______ _________        _________ _________ _________ _________ _________ _________ _________ _________

Ra-226  Ra-226  1.000E+00       1.000E+00 9.987E-01 9.937E-01 9.875E-01 9.690E-01 9.509E-01 9.331E-01 9.156E-01
Ra-226  Th-230  1.000E+00       0.000E+00 4.329E-04 2.159E-03 4.305E-03 1.066E-02 1.690E-02 2.301E-02 2.902E-02
Ra-226  U-234   1.000E+00       0.000E+00 1.948E-09 4.855E-08 1.934E-07 1.194E-06 3.021E-06 5.642E-06 9.030E-06
Ra-226  U-238   1.000E+00       0.000E+00 1.844E-15 2.293E-13 1.826E-12 2.815E-11 1.138E-10 2.918E-10 5.937E-10
Ra-226  ∑S(j):                  1.000E+00 9.992E-01 9.959E-01 9.918E-01 9.797E-01 9.678E-01 9.561E-01 9.446E-01

Th-230  Th-230  1.000E+00       1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.998E-01 9.996E-01 9.995E-01 9.993E-01
Th-230  U-234   1.000E+00       0.000E+00 8.997E-06 4.488E-05 8.950E-05 2.218E-04 3.518E-04 4.795E-04 6.050E-04
Th-230  U-238   1.000E+00       0.000E+00 1.275E-11 3.178E-10 1.266E-09 7.822E-09 1.979E-08 3.699E-08 5.923E-08
Th-230  ∑S(j):                  1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01

U-234   U-234   1.000E+00       1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.714E-01 9.547E-01 9.382E-01 9.221E-01
U-234   U-238   1.000E+00       0.000E+00 2.832E-06 1.409E-05 2.802E-05 6.885E-05 1.083E-04 1.463E-04 1.830E-04
U-234   ∑S(j):                  1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01

U-238   U-238   1.000E+00       1.000E+00 9.988E-01 9.942E-01 9.885E-01 9.715E-01 9.548E-01 9.384E-01 9.223E-01
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BRF(i) is the branch fraction of the parent nuclide.
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RESRAD OUTPUT FOR RESIDENT – SOIL
SUPPORT FOR DERIVATION OF CLEAN UP GOAL

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

```
                         Dose Conversion Factor (and Related) Parameter Summary
                                           File: DOSFAC.BIN

     |                                                          |  Current   |            | Parameter
Menu |                        Parameter                         |   Value    |  Default   |   Name
-----+----------------------------------------------------------+------------+------------+-------------
B-1  | Dose conversion factors for inhalation, mrem/pCi:        |            |            |
B-1  | Ac-227+D                                                 | 6.720E+00  | 6.720E+00  | DCF2( 1)
B-1  | Co-57                                                    | 9.070E-06  | 9.070E-06  | DCF2( 2)
B-1  | Co-60                                                    | 2.190E-04  | 2.190E-04  | DCF2( 3)
B-1  | Cs-137+D                                                 | 3.190E-05  | 3.190E-05  | DCF2( 4)
B-1  | H-3                                                      | 6.400E-08  | 6.400E-08  | DCF2( 5)
B-1  | Pa-231                                                   | 1.280E+00  | 1.280E+00  | DCF2( 6)
B-1  | Pb-210+D                                                 | 2.320E-02  | 2.320E-02  | DCF2( 7)
B-1  | Pu-239                                                   | 4.290E-01  | 4.290E-01  | DCF2( 8)
B-1  | Pu-240                                                   | 4.290E-01  | 4.290E-01  | DCF2( 9)
B-1  | Ra-226+D                                                 | 8.600E-03  | 8.600E-03  | DCF2(10)
B-1  | Ra-228+D                                                 | 5.080E-03  | 5.080E-03  | DCF2(11)
B-1  | Th-228+D                                                 | 3.450E-01  | 3.450E-01  | DCF2(12)
B-1  | Th-230                                                   | 3.260E-01  | 3.260E-01  | DCF2(13)
B-1  | Th-232                                                   | 1.640E+00  | 1.640E+00  | DCF2(14)
B-1  | U-234                                                    | 1.320E-01  | 1.320E-01  | DCF2(15)
B-1  | U-235+D                                                  | 1.230E-01  | 1.230E-01  | DCF2(16)
B-1  | U-236                                                    | 1.250E-01  | 1.250E-01  | DCF2(17)
B-1  | U-238+D                                                  | 1.180E-01  | 1.180E-01  | DCF2(18)
     |                                                          |            |            |
D-1  | Dose conversion factors for ingestion, mrem/pCi:         |            |            |
D-1  | Ac-227+D                                                 | 1.480E-02  | 1.480E-02  | DCF3( 1)
D-1  | Co-57                                                    | 1.180E-06  | 1.180E-06  | DCF3( 2)
D-1  | Co-60                                                    | 2.690E-05  | 2.690E-05  | DCF3( 3)
D-1  | Cs-137+D                                                 | 5.000E-05  | 5.000E-05  | DCF3( 4)
D-1  | H-3                                                      | 6.400E-08  | 6.400E-08  | DCF3( 5)
D-1  | Pa-231                                                   | 1.060E-02  | 1.060E-02  | DCF3( 6)
D-1  | Pb-210+D                                                 | 7.270E-03  | 7.270E-03  | DCF3( 7)
D-1  | Pu-239                                                   | 3.540E-03  | 3.540E-03  | DCF3( 8)
D-1  | Pu-240                                                   | 3.540E-03  | 3.540E-03  | DCF3( 9)
D-1  | Ra-226+D                                                 | 1.330E-03  | 1.330E-03  | DCF3(10)
D-1  | Ra-228+D                                                 | 1.440E-03  | 1.440E-03  | DCF3(11)
D-1  | Th-228+D                                                 | 8.080E-04  | 8.080E-04  | DCF3(12)
D-1  | Th-230                                                   | 5.480E-04  | 5.480E-04  | DCF3(13)
D-1  | Th-232                                                   | 2.730E-03  | 2.730E-03  | DCF3(14)
D-1  | U-234                                                    | 2.830E-04  | 2.830E-04  | DCF3(15)
D-1  | U-235+D                                                  | 2.670E-04  | 2.670E-04  | DCF3(16)
  1  | U-236                                                    | 2.690E-04  | 2.690E-04  | DCF3(17)
  1  | U-238+D                                                  | 2.690E-04  | 2.690E-04  | DCF3(18)
     |                                                          |            |            |
D-34 | Food transfer factors:                                   |            |            |
D-34 | Ac-227+D , plant/soil concentration ratio, dimensionless | 2.500E-03  | 2.500E-03  | RTF( 1,1)
D-34 | Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-05  | 2.000E-05  | RTF( 1,2)
D-34 | Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 2.000E-05  | 2.000E-05  | RTF( 1,3)
D-34 |                                                          |            |            |
D-34 | Co-57    , plant/soil concentration ratio, dimensionless | 8.000E-02  | 8.000E-02  | RTF( 2,1)
D-34 | Co-57    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-02  | 2.000E-02  | RTF( 2,2)
D-34 | Co-57    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  | 2.000E-03  | 2.000E-03  | RTF( 2,3)
D-34 |                                                          |            |            |
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Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(3,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(3,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(3,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(4,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(4,3)
D-34				
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(5,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(5,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(5,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(6,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(6,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(7,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(7,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(7,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(8,3)
D-34				
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(9,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(9,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(9,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(10,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(11,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(11,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(11,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(12,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(12,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(12,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(13,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(13,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(13,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(14,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(14,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(14,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(15,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(15,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(15,3)

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                    Dose Conversion Factor (and Related) Parameter Summary (continued)
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     |                                                            | Current  |          | Parameter
Menu |                        Parameter                           |  Value   | Default  |   Name
-----+------------------------------------------------------------+----------+----------+--------------
D-34 | U-235+D  , plant/soil concentration ratio, dimensionless   | 2.500E-03| 2.500E-03| RTF(16,1)
D-34 | U-235+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 3.400E-04| 3.400E-04| RTF(16,2)
D-34 | U-235+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 6.000E-04| 6.000E-04| RTF(16,3)
D-34 |                                                            |          |          |
D-34 | U-236    , plant/soil concentration ratio, dimensionless   | 2.500E-03| 2.500E-03| RTF(17,1)
D-34 | U-236    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 3.400E-04| 3.400E-04| RTF(17,2)
D-34 | U-236    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 6.000E-04| 6.000E-04| RTF(17,3)
D-34 |                                                            |          |          |
D-34 | U-238+D  , plant/soil concentration ratio, dimensionless   | 2.500E-03| 2.500E-03| RTF(18,1)
D-34 | U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   | 3.400E-04| 3.400E-04| RTF(18,2)
D-34 | U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    | 6.000E-04| 6.000E-04| RTF(18,3)
     |                                                            |          |          |
D-5  | Bioaccumulation factors, fresh water, L/kg:                |          |          |
D-5  | Ac-227+D , fish                                            | 1.500E+01| 1.500E+01| BIOFAC( 1,1)
D-5  | Ac-227+D , crustacea and mollusks                          | 1.000E+03| 1.000E+03| BIOFAC( 1,2)
D-5  |                                                            |          |          |
D-5  | Co-57    , fish                                            | 3.000E+02| 3.000E+02| BIOFAC( 2,1)
D-5  | Co-57    , crustacea and mollusks                          | 2.000E+02| 2.000E+02| BIOFAC( 2,2)
D-5  |                                                            |          |          |
D-5  | Co-60    , fish                                            | 3.000E+02| 3.000E+02| BIOFAC( 3,1)
D-5  | Co-60    , crustacea and mollusks                          | 2.000E+02| 2.000E+02| BIOFAC( 3,2)
D-5  |                                                            |          |          |
D-5  | Cs-137+D , fish                                            | 2.000E+03| 2.000E+03| BIOFAC( 4,1)
D-5  | Cs-137+D , crustacea and mollusks                          | 1.000E+02| 1.000E+02| BIOFAC( 4,2)
D-5  |                                                            |          |          |
D-5  | H-3      , fish                                            | 1.000E+00| 1.000E+00| BIOFAC( 5,1)
D-5  | H-3      , crustacea and mollusks                          | 1.000E+00| 1.000E+00| BIOFAC( 5,2)
D-5  |                                                            |          |          |
D-5  | Pa-231   , fish                                            | 1.000E+01| 1.000E+01| BIOFAC( 6,1)
D-5  | Pa-231   , crustacea and mollusks                          | 1.100E+02| 1.100E+02| BIOFAC( 6,2)
D-5  |                                                            |          |          |
D-5  | Pb-210+D , fish                                            | 3.000E+02| 3.000E+02| BIOFAC( 7,1)
D-5  | Pb-210+D , crustacea and mollusks                          | 1.000E+02| 1.000E+02| BIOFAC( 7,2)
D-5  |                                                            |          |          |
D-5  | Pu-239   , fish                                            | 3.000E+01| 3.000E+01| BIOFAC( 8,1)
D-5  | Pu-239   , crustacea and mollusks                          | 1.000E+02| 1.000E+02| BIOFAC( 8,2)
D-5  |                                                            |          |          |
D-5  | Pu-240   , fish                                            | 3.000E+01| 3.000E+01| BIOFAC( 9,1)
D-5  | Pu-240   , crustacea and mollusks                          | 1.000E+02| 1.000E+02| BIOFAC( 9,2)
D-5  |                                                            |          |          |
D-5  | Ra-226+D , fish                                            | 5.000E+01| 5.000E+01| BIOFAC(10,1)
D-5  | Ra-226+D , crustacea and mollusks                          | 2.500E+02| 2.500E+02| BIOFAC(10,2)
D-5  |                                                            |          |          |
D-5  | Ra-228+D , fish                                            | 5.000E+01| 5.000E+01| BIOFAC(11,1)
D-5  | Ra-228+D , crustacea and mollusks                          | 2.500E+02| 2.500E+02| BIOFAC(11,2)
D-5  |                                                            |          |          |
D-5  | Th-228+D , fish                                            | 1.000E+02| 1.000E+02| BIOFAC(12,1)
D-5  | Th-228+D , crustacea and mollusks                          | 5.000E+02| 5.000E+02| BIOFAC(12,2)
D-5  |                                                            |          |          |
D-5  | Th-230   , fish                                            | 1.000E+02| 1.000E+02| BIOFAC(13,1)
D-5  | Th-230   , crustacea and mollusks                          | 5.000E+02| 5.000E+02| BIOFAC(13,2)
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Dose Conversion Factor (and Related) Parameter Summary (continued)
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Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(14,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(14,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(15,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(15,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(16,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(16,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(17,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(17,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(18,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(18,2)

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                              Site-Specific Parameter Summary (continued)

     |                                        |    User    |            |         Used by RESRAD              |   Parameter
Menu |                Parameter               |    Input   |  Default   | (If different from user input)      |     Name
-----+----------------------------------------+------------+------------+-------------------------------------+--------------
R016 | Distribution coefficients for Co-60    |            |            |                                     |
R016 |   Contaminated zone (cm**3/g)          |  1.000E+03 |  1.000E+03 |                 ---                 | DCNUCC( 3)
R016 |   Unsaturated zone 1 (cm**3/g)         |  1.000E+03 |  1.000E+03 |                 ---                 | DCNUCU( 3,1)
R016 |   Saturated zone (cm**3/g)             |  1.000E+03 |  1.000E+03 |                 ---                 | DCNUCS( 3)
R016 |   Leach rate (/yr)                     |  0.000E+00 |  0.000E+00 |              5.999E-05              | ALEACH( 3)
R016 |   Solubility constant                  |  0.000E+00 |  0.000E+00 |              not used               | SOLUBK( 3)
     |                                        |            |            |                                     |
R016 | Distribution coefficients for Cs-137   |            |            |                                     |
R016 |   Contaminated zone (cm**3/g)          |  1.000E+03 |  1.000E+03 |                 ---                 | DCNUCC( 4)
R016 |   Unsaturated zone 1 (cm**3/g)         |  1.000E+03 |  1.000E+03 |                 ---                 | DCNUCU( 4,1)
R016 |   Saturated zone (cm**3/g)             |  1.000E+03 |  1.000E+03 |                 ---                 | DCNUCS( 4)
R016 |   Leach rate (/yr)                     |  0.000E+00 |  0.000E+00 |              5.999E-05              | ALEACH( 4)
R016 |   Solubility constant                  |  0.000E+00 |  0.000E+00 |              not used               | SOLUBK( 4)
     |                                        |            |            |                                     |
R016 | Distribution coefficients for H-3      |            |            |                                     |
R016 |   Contaminated zone (cm**3/g)          |  0.000E+00 |  0.000E+00 |                 ---                 | DCNUCC( 5)
R016 |   Unsaturated zone 1 (cm**3/g)         |  0.000E+00 |  0.000E+00 |                 ---                 | DCNUCU( 5,1)
R016 |   Saturated zone (cm**3/g)             |  0.000E+00 |  0.000E+00 |                 ---                 | DCNUCS( 5)
R016 |   Leach rate (/yr)                     |  0.000E+00 |  0.000E+00 |              3.561E-01              | ALEACH( 5)
R016 |   Solubility constant                  |  0.000E+00 |  0.000E+00 |              not used               | SOLUBK( 5)
     |                                        |            |            |                                     |
R016 | Distribution coefficients for Pb-210   |            |            |                                     |
R016 |   Contaminated zone (cm**3/g)          |  1.000E+02 |  1.000E+02 |                 ---                 | DCNUCC( 7)
R016 |   Unsaturated zone 1 (cm**3/g)         |  1.000E+02 |  1.000E+02 |                 ---                 | DCNUCU( 7,1)
R016 |   Saturated zone (cm**3/g)             |  1.000E+02 |  1.000E+02 |                 ---                 | DCNUCS( 7)
R016 |   Leach rate (/yr)                     |  0.000E+00 |  0.000E+00 |              5.990E-04              | ALEACH( 7)
R016 |   Solubility constant                  |  0.000E+00 |  0.000E+00 |              not used               | SOLUBK( 7)
     |                                        |            |            |                                     |
R016 | Distribution coefficients for Pu-239   |            |            |                                     |
R016 |   Contaminated zone (cm**3/g)          |  2.000E+03 |  2.000E+03 |                 ---                 | DCNUCC( 8)
R016 |   Unsaturated zone 1 (cm**3/g)         |  2.000E+03 |  2.000E+03 |                 ---                 | DCNUCU( 8,1)
R016 |   Saturated zone (cm**3/g)             |  2.000E+03 |  2.000E+03 |                 ---                 | DCNUCS( 8)
R016 |   Leach rate (/yr)                     |  0.000E+00 |  0.000E+00 |              3.000E-05              | ALEACH( 8)
R016 |   Solubility constant                  |  0.000E+00 |  0.000E+00 |              not used               | SOLUBK( 8)
     |                                        |            |            |                                     |
R016 | Distribution coefficients for Pu-240   |            |            |                                     |
R016 |   Contaminated zone (cm**3/g)          |  2.000E+03 |  2.000E+03 |                 ---                 | DCNUCC( 9)
R016 |   Unsaturated zone 1 (cm**3/g)         |  2.000E+03 |  2.000E+03 |                 ---                 | DCNUCU( 9,1)
R016 |   Saturated zone (cm**3/g)             |  2.000E+03 |  2.000E+03 |                 ---                 | DCNUCS( 9)
R016 |   Leach rate (/yr)                     |  0.000E+00 |  0.000E+00 |              3.000E-05              | ALEACH( 9)
R016 |   Solubility constant                  |  0.000E+00 |  0.000E+00 |              not used               | SOLUBK( 9)
     |                                        |            |            |                                     |
R016 | Distribution coefficients for Ra-226   |            |            |                                     |
R016 |   Contaminated zone (cm**3/g)          |  7.000E+01 |  7.000E+01 |                 ---                 | DCNUCC(10)
R016 |   Unsaturated zone 1 (cm**3/g)         |  7.000E+01 |  7.000E+01 |                 ---                 | DCNUCU(10,1)
R016 |   Saturated zone (cm**3/g)             |  7.000E+01 |  7.000E+01 |                 ---                 | DCNUCS(10)
R016 |   Leach rate (/yr)                     |  0.000E+00 |  0.000E+00 |              8.551E-04              | ALEACH(10)
R016 |   Solubility constant                  |  0.000E+00 |  0.000E+00 |              not used               | SOLUBK(10)
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                                      Site-Specific Parameter Summary (continued)

     |                                                  |   User     |            |          Used by RESRAD            |  Parameter
Menu |                     Parameter                    |   Input    |  Default   |   (If different from user input)   |    Name
-----+--------------------------------------------------+------------+------------+------------------------------------+-------------
R016 | Distribution coefficients for Ra-228             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCC(11)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCU(11,1)
R016 |   Saturated zone (cm**3/g)                       |  7.000E+01 |  7.000E+01 |                ---                 | DCNUCS(11)
R016 |   Leach rate (/yr)                               |  0.000E+00 |  0.000E+00 |             8.551E-04              | ALEACH(11)
R016 |   Solubility constant                            |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(11)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Th-228             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCC(12)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCU(12,1)
R016 |   Saturated zone (cm**3/g)                       |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCS(12)
R016 |   Leach rate (/yr)                               |  0.000E+00 |  0.000E+00 |             1.000E-06              | ALEACH(12)
R016 |   Solubility constant                            |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(12)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Th-230             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCC(13)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCU(13,1)
R016 |   Saturated zone (cm**3/g)                       |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCS(13)
R016 |   Leach rate (/yr)                               |  0.000E+00 |  0.000E+00 |             1.000E-06              | ALEACH(13)
R016 |   Solubility constant                            |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(13)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for Th-232             |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCC(14)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCU(14,1)
R016 |   Saturated zone (cm**3/g)                       |  6.000E+04 |  6.000E+04 |                ---                 | DCNUCS(14)
R016 |   Leach rate (/yr)                               |  0.000E+00 |  0.000E+00 |             1.000E-06              | ALEACH(14)
R016 |   Solubility constant                            |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(14)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for U-234              |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCC(15)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCU(15,1)
R016 |   Saturated zone (cm**3/g)                       |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCS(15)
R016 |   Leach rate (/yr)                               |  0.000E+00 |  0.000E+00 |             1.196E-03              | ALEACH(15)
R016 |   Solubility constant                            |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(15)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for U-235              |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCC(16)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCU(16,1)
R016 |   Saturated zone (cm**3/g)                       |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCS(16)
R016 |   Leach rate (/yr)                               |  0.000E+00 |  0.000E+00 |             1.196E-03              | ALEACH(16)
R016 |   Solubility constant                            |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(16)
     |                                                  |            |            |                                    |
R016 | Distribution coefficients for U-238              |            |            |                                    |
R016 |   Contaminated zone (cm**3/g)                    |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCC(18)
R016 |   Unsaturated zone 1 (cm**3/g)                   |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCU(18,1)
R016 |   Saturated zone (cm**3/g)                       |  5.000E+01 |  5.000E+01 |                ---                 | DCNUCS(18)
R016 |   Leach rate (/yr)                               |  0.000E+00 |  0.000E+00 |             1.196E-03              | ALEACH(18)
R016 |   Solubility constant                            |  0.000E+00 |  0.000E+00 |             not used               | SOLUBK(18)
```

```
                              Site-Specific Parameter Summary (continued)

     |                                                  |   User    |           |     Used by RESRAD              |  Parameter
Menu |                   Parameter                      |   Input   |  Default  | (If different from user input)  |    Name
-----+--------------------------------------------------+-----------+-----------+---------------------------------+----------------
R016 | Distribution coefficients for daughter Pa-231    |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)                    | 5.000E+01 | 5.000E+01 |              ---                | DCNUCC( 6)
R016 |   Unsaturated zone 1 (cm**3/g)                   | 5.000E+01 | 5.000E+01 |              ---                | DCNUCU( 6,1)
R016 |   Saturated zone (cm**3/g)                       | 5.000E+01 | 5.000E+01 |              ---                | DCNUCS( 6)
R016 |   Leach rate (/yr)                               | 0.000E+00 | 0.000E+00 |           1.196E-03             | ALEACH( 6)
R016 |   Solubility constant                            | 0.000E+00 | 0.000E+00 |           not used              | SOLUBK( 6)
     |                                                  |           |           |                                 |
R016 | Distribution coefficients for daughter U-236     |           |           |                                 |
R016 |   Contaminated zone (cm**3/g)                    | 5.000E+01 | 5.000E+01 |              ---                | DCNUCC(17)
R016 |   Unsaturated zone 1 (cm**3/g)                   | 5.000E+01 | 5.000E+01 |              ---                | DCNUCU(17,1)
R016 |   Saturated zone (cm**3/g)                       | 5.000E+01 | 5.000E+01 |              ---                | DCNUCS(17)
R016 |   Leach rate (/yr)                               | 0.000E+00 | 0.000E+00 |           1.196E-03             | ALEACH(17)
R016 |   Solubility constant                            | 0.000E+00 | 0.000E+00 |           not used              | SOLUBK(17)
     |                                                  |           |           |                                 |
R017 | Inhalation rate (m**3/yr)                        | 7.300E+03 | 8.400E+03 |              ---                | INHALR
R017 | Mass loading for inhalation (g/m**3)             | 1.000E-04 | 1.000E-04 |              ---                | MLINH
R017 | Exposure duration                                | 3.000E+01 | 3.000E+01 |              ---                | ED
R017 | Shielding factor, inhalation                     | 4.000E-01 | 4.000E-01 |              ---                | SHF3
R017 | Shielding factor, external gamma                 | 7.000E-01 | 7.000E-01 |              ---                | SHF1
R017 | Fraction of time spent indoors                   | 5.000E-01 | 5.000E-01 |              ---                | FIND
R017 | Fraction of time spent outdoors (on site)        | 2.500E-01 | 2.500E-01 |              ---                | FOTD
R017 | Shape factor flag, external gamma                | 1.000E+00 | 1.000E+00 |   >0 shows circular AREA.       | FS
R017 | Radii of shape factor array (used if FS = -1):   |           |           |                                 |
R017 |   Outer annular radius (m), ring  1:             | not used  | 5.000E+01 |              ---                | RAD SHAPE( 1)
R017 |   Outer annular radius (m), ring  2:             | not used  | 7.071E+01 |              ---                | RAD SHAPE( 2)
R017 |   Outer annular radius (m), ring  3:             | not used  | 0.000E+00 |              ---                | RAD SHAPE( 3)
R017 |   Outer annular radius (m), ring  4:             | not used  | 0.000E+00 |              ---                | RAD SHAPE( 4)
R017 |   Outer annular radius (m), ring  5:             | not used  | 0.000E+00 |              ---                | RAD SHAPE( 5)
R017 |   Outer annular radius (m), ring  6:             | not used  | 0.000E+00 |              ---                | RAD SHAPE( 6)
R017 |   Outer annular radius (m), ring  7:             | not used  | 0.000E+00 |              ---                | RAD SHAPE( 7)
R017 |   Outer annular radius (m), ring  8:             | not used  | 0.000E+00 |              ---                | RAD SHAPE( 8)
R017 |   Outer annular radius (m), ring  9:             | not used  | 0.000E+00 |              ---                | RAD SHAPE( 9)
R017 |   Outer annular radius (m), ring 10:             | not used  | 0.000E+00 |              ---                | RAD SHAPE(10)
R017 |   Outer annular radius (m), ring 11:             | not used  | 0.000E+00 |              ---                | RAD SHAPE(11)
R017 |   Outer annular radius (m), ring 12:             | not used  | 0.000E+00 |              ---                | RAD_SHAPE(12)
     |                                                  |           |           |                                 |
R017 | Fractions of annular areas within AREA:          |           |           |                                 |
R017 |   Ring  1                                        | not used  | 1.000E+00 |              ---                | FRACA( 1)
R017 |   Ring  2                                        | not used  | 2.732E-01 |              ---                | FRACA( 2)
R017 |   Ring  3                                        | not used  | 0.000E+00 |              ---                | FRACA( 3)
R017 |   Ring  4                                        | not used  | 0.000E+00 |              ---                | FRACA( 4)
R017 |   Ring  5                                        | not used  | 0.000E+00 |              ---                | FRACA( 5)
R017 |   Ring  6                                        | not used  | 0.000E+00 |              ---                | FRACA( 6)
R017 |   Ring  7                                        | not used  | 0.000E+00 |              ---                | FRACA( 7)
R017 |   Ring  8                                        | not used  | 0.000E+00 |              ---                | FRACA( 8)
R017 |   Ring  9                                        | not used  | 0.000E+00 |              ---                | FRACA( 9)
R017 |   Ring 10                                        | not used  | 0.000E+00 |              ---                | FRACA(10)
R017 |   Ring 11                                        | not used  | 0.000E+00 |              ---                | FRACA(11)
R017 |   Ring 12                                        | not used  | 0.000E+00 |              ---                | FRACA(12)
     |                                                  |           |           |                                 |
R018 | Fruits, vegetables and grain consumption (kg/yr) | not used  | 1.600E+02 |              ---                | DIET(1)
```

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.000E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC

```
                                          Site-Specific Parameter Summary (continued)

     |                                                   |   User     |            |     Used by RESRAD                 |  Parameter
Menu |                      Parameter                    |   Input    |  Default   | (If different from user input)     |    Name
-----+---------------------------------------------------+------------+------------+------------------------------------+--------------
C14  | C-14 evasion flux rate from soil (1/sec)          | not used   | 7.000E-07  |              ---                   | EVSN
C14  | C-12 evasion flux rate from soil (1/sec)          | not used   | 1.000E-10  |              ---                   | REVSN
C14  | Fraction of grain in beef cattle feed             | not used   | 8.000E-01  |              ---                   | AVFG4
C14  | Fraction of grain in milk cow feed                | not used   | 2.000E-01  |              ---                   | AVFG5
     |                                                   |            |            |                                    |
STOR | Storage times of contaminated foodstuffs (days):  |            |            |                                    |
STOR |   Fruits, non-leafy vegetables, and grain         | 1.400E+01  | 1.400E+01  |              ---                   | STOR_T(1)
STOR |   Leafy vegetables                                | 1.000E+00  | 1.000E+00  |              ---                   | STOR_T(2)
STOR |   Milk                                            | 1.000E+00  | 1.000E+00  |              ---                   | STOR_T(3)
STOR |   Meat and poultry                                | 2.000E+01  | 2.000E+01  |              ---                   | STOR_T(4)
STOR |   Fish                                            | 7.000E+00  | 7.000E+00  |              ---                   | STOR_T(5)
STOR |   Crustacea and mollusks                          | 7.000E+00  | 7.000E+00  |              ---                   | STOR_T(6)
STOR |   Well water                                      | 1.000E+00  | 1.000E+00  |              ---                   | STOR_T(7)
STOR |   Surface water                                   | 1.000E+00  | 1.000E+00  |              ---                   | STOR_T(8)
STOR |   Livestock fodder                                | 4.500E+01  | 4.500E+01  |              ---                   | STOR_T(9)
     |                                                   |            |            |                                    |
R021 | Thickness of building foundation (m)              | not used   | 1.500E-01  |              ---                   | FLOOR
R021 | Bulk density of building foundation (g/cm**3)     | not used   | 2.400E+00  |              ---                   | DENSFL
R021 | Total porosity of the cover material              | not used   | 4.000E-01  |              ---                   | TPCV
R021 | Total porosity of the building foundation         | not used   | 1.000E-01  |              ---                   | TPFL
R021 | Volumetric water content of the cover material    | not used   | 5.000E-02  |              ---                   | PH2OCV
R021 | Volumetric water content of the foundation        | not used   | 3.000E-02  |              ---                   | PH2OFL
R021 | Diffusion coefficient for radon gas (m/sec):      |            |            |                                    |
R021 |   in cover material                               | not used   | 2.000E-06  |              ---                   | DIFCV
R021 |   in foundation material                          | not used   | 3.000E-07  |              ---                   | DIFFL
R021 |   in contaminated zone soil                       | not used   | 2.000E-06  |              ---                   | DIFCZ
R021 | Radon vertical dimension of mixing (m)            | not used   | 2.000E+00  |              ---                   | HMIX
R021 | Average building air exchange rate (1/hr)         | not used   | 5.000E-01  |              ---                   | REXG
R021 | Height of the building (room) (m)                 | not used   | 2.500E+00  |              ---                   | HRM
R021 | Building interior area factor                     | not used   | 0.000E+00  |              ---                   | FAI
R021 | Building depth below ground surface (m)           | not used   |-1.000E+00  |              ---                   | DMFL
R021 | Emanating power of Rn-222 gas                     | not used   | 2.500E-01  |              ---                   | EMANA(1)
R021 | Emanating power of Rn-220 gas                     | not used   | 1.500E-01  |              ---                   | EMANA(2)
=================================================================================================================================


                    Summary of Pathway Selections

                   Pathway               |  User Selection
      -----------------------------------+-----------------
       1 -- external gamma               |     active
       2 -- inhalation (w/o radon)       |     active
       3 -- plant ingestion              |   suppressed
       4 -- meat ingestion               |   suppressed
       5 -- milk ingestion               |   suppressed
       6 -- aquatic foods                |   suppressed
       7 -- drinking water               |     active
       8 -- soil ingestion               |     active
       9 -- radon                        |   suppressed
       Find peak pathway doses           |   suppressed
      ===================================================
```

```
     Contaminated Zone Dimensions           Initial Soil Concentrations, pCi/g
     ____________________________           __________________________________

       Area:   3439.00 square meters                  Ac-227      1.000E+00
  Thickness:      2.00 meters                         Co-57       1.000E+00
Cover Depth:      0.00 meters                         Co-60       1.000E+00
                                                      Cs-137      1.000E+00
                                                      H-3         1.000E+00
                                                      Pb-210      1.000E+00
                                                      Pu-239      1.000E+00
                                                      Pu-240      1.000E+00
                                                      Ra-226      1.000E+00
                                                      Ra-228      1.000E+00
                                                      Th-228      1.000E+00
                                                      Th-230      1.000E+00
                                                      Th-232      1.000E+00
                                                      U-234       1.000E+00
                                                      U-235       1.000E+00
                                                      U-238       1.000E+00

                                      Total Dose TDOSE(t), mrem/yr
                                Basic Radiation Dose Limit =  10 mrem/yr
                 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                 __________________________________________________________________________

   t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
    TDOSE(t):  2.924E+01  2.788E+01  2.419E+01  2.143E+01  1.829E+01  1.730E+01  1.677E+01  1.642E+01
        M(t):  2.924E+00  2.788E+00  2.419E+00  2.143E+00  1.829E+00  1.730E+00  1.677E+00  1.642E+00

Maximum TDOSE(t):  2.924E+01 mrem/yr   at t = 0.000E+00 years
```

```
                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                        As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                          Water Independent Pathways (Inhalation excludes radon)

              Ground              Inhalation              Radon                 Plant                 Meat                  Milk                  Soil
Radio-   -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide   mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
-------  --------- ------     --------- ------     --------- ------     --------- ------     --------- ------     --------- ------     --------- ------
Ac-227   1.115E+00 0.0381     2.911E-01 0.0100     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     4.051E-01 0.0139
Co-57    2.816E-01 0.0096     3.929E-07 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.230E-05 0.0000
Co-60    8.914E+00 0.3049     9.486E-06 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.364E-04 0.0000
Cs-137   1.863E+00 0.0637     1.382E-06 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.369E-03 0.0000
H-3      0.000E+00 0.0000     2.706E-04 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.752E-06 0.0000
Pb-210   3.498E-03 0.0001     1.005E-03 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.990E-01 0.0068
Pu-239   1.669E-04 0.0000     1.858E-02 0.0006     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     9.691E-02 0.0033
Pu-240   8.635E-05 0.0000     1.858E-02 0.0006     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     9.691E-02 0.0033
Ra-226   6.174E+00 0.2112     3.725E-04 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.641E-02 0.0012
Ra-228   3.293E+00 0.1126     2.200E-04 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.942E-02 0.0013
Th-228   5.636E+00 0.1928     1.494E-02 0.0005     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     2.212E-02 0.0008
Th-230   6.823E-04 0.0000     1.412E-02 0.0005     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.500E-02 0.0005
Th-232   2.951E-04 0.0000     7.104E-02 0.0024     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.473E-02 0.0026
U-234    2.287E-04 0.0000     5.718E-03 0.0002     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.747E-03 0.0003
U-235    4.235E-01 0.0145     5.328E-03 0.0002     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.309E-03 0.0002
U-238    7.565E-02 0.0026     5.111E-03 0.0002     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.364E-03 0.0003
=======  ========= ======     ========= ======     ========= ======     ========= ======     ========= ======     ========= ======     ========= ======
Total    2.778E+01 0.9502     4.464E-01 0.0153     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.010E+00 0.0346
```

```
                       Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

                                                        Water Dependent Pathways

             Water                 Fish                Radon                Plant                 Meat                 Milk             All Pathways*
Radio-  -------------------- -------------------- -------------------- -------------------- -------------------- -------------------- --------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
------- ---------- -------- ---------- -------- ---------- -------- ---------- -------- ---------- -------- ---------- -------- ---------- --------
Ac-227  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.811E+00  0.0619
Co-57   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.817E-01  0.0096
Co-60   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.915E+00  0.3049
Cs-137  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.864E+00  0.0638
H-3     0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.724E-04  0.0000
Pb-210  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.035E-01  0.0070
Pu-239  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.157E-01  0.0040
Pu-240  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.156E-01  0.0040
Ra-226  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.211E+00  0.2124
Ra-228  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.333E+00  0.1140
Th-228  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.673E+00  0.1940
Th-230  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.981E-02  0.0010
Th-232  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.461E-01  0.0050
U-234   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.369E-02  0.0005
U-235   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.361E-01  0.0149
U-238   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.812E-02  0.0030
======= ========== ======== ========== ======== ========== ======== ========== ======== ========== ======== ========== ======== ========== ========
Total   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.924E+01  1.0000

*Sum of all water independent and dependent pathways.
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```
                                 Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                 As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                     Water Independent Pathways (Inhalation excludes radon)

               Ground             Inhalation             Radon                 Plant                 Meat                  Milk                  Soil
Radio-    ------------------   ------------------   ------------------   ------------------   ------------------   ------------------   ------------------
Nuclide   mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------   ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
Ac-227    1.077E+00  0.0386    2.811E-01  0.0101    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.913E-01  0.0140
Co-57     1.106E-01  0.0040    1.543E-07  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.269E-05  0.0000
Co-60     7.816E+00  0.2803    8.317E-06  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    6.456E-04  0.0000
Cs-137    1.820E+00  0.0653    1.350E-06  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.337E-03  0.0000
H-3       0.000E+00  0.0000    7.796E-05  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    5.047E-07  0.0000
Pb-210    3.388E-03  0.0001    9.736E-04  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.928E-01  0.0069
Pu-239    1.669E-04  0.0000    1.858E-02  0.0007    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    9.690E-02  0.0035
Pu-240    8.633E-05  0.0000    1.858E-02  0.0007    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    9.689E-02  0.0035
Ra-226    6.166E+00  0.2212    4.028E-04  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    4.245E-02  0.0015
Ra-228    4.524E+00  0.1623    4.456E-03  0.0002    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    4.122E-02  0.0015
Th-228    3.923E+00  0.1407    1.040E-02  0.0004    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.540E-02  0.0006
Th-230    3.355E-03  0.0001    1.412E-02  0.0005    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.502E-02  0.0005
Th-232    4.792E-01  0.0172    7.134E-02  0.0026    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    7.962E-02  0.0029
U-234     2.285E-04  0.0000    5.711E-03  0.0002    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    7.738E-03  0.0003
U-235     4.230E-01  0.0152    5.323E-03  0.0002    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    7.307E-03  0.0003
U-238     7.556E-02  0.0027    5.105E-03  0.0002    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    7.355E-03  0.0003
=======   =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======
Total     2.642E+01  0.9477    4.362E-01  0.0156    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    9.960E-01  0.0357
```

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                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                              As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

                                                  Water Dependent Pathways

             Water                Fish                Radon                Plant                 Meat                 Milk             All Pathways*
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
------- --------- ------     --------- ------     --------- ------     --------- ------     --------- ------     --------- ------     --------- ------

Ac-227  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.749E+00 0.0627
Co-57   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.106E-01 0.0040
Co-60   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   7.816E+00 0.2803
Cs-137  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.822E+00 0.0653
H-3     2.708E-02 0.0010   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.716E-02 0.0010
Pb-210  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.972E-01 0.0071
Pu-239  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.157E-01 0.0041
Pu-240  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.156E-01 0.0041
Ra-226  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.209E+00 0.2227
Ra-228  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.570E+00 0.1639
Th-228  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.949E+00 0.1416
Th-230  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   3.250E-02 0.0012
Th-232  0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   6.302E-01 0.0226
U-234   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   1.368E-02 0.0005
U-235   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   4.356E-01 0.0156
U-238   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   8.802E-02 0.0032
======= ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======   ========= ======
Total   2.708E-02 0.0010   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   0.000E+00 0.0000   2.788E+01 1.0000

*Sum of all water independent and dependent pathways.
```

```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                        Water Independent Pathways (Inhalation excludes radon)

             Ground            Inhalation            Radon              Plant              Meat               Milk               Soil
Radio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Ac-227  9.369E-01 0.0387  2.446E-01 0.0101  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.404E-01 0.0141
Co-57   2.632E-03 0.0001  3.671E-09 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.018E-07 0.0000
Co-60   4.618E+00 0.1909  4.914E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.814E-04 0.0000
Cs-137  1.659E+00 0.0686  1.231E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.219E-03 0.0001
H-3     0.000E+00 0.0000  5.364E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.472E-09 0.0000
Pb-210  2.985E-03 0.0001  8.577E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.699E-01 0.0070
Pu-239  1.669E-04 0.0000  1.858E-02 0.0008  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.688E-02 0.0040
Pu-240  8.629E-05 0.0000  1.857E-02 0.0008  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.684E-02 0.0040
Ra-226  6.135E+00 0.2536  5.141E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.469E-02 0.0027
Ra-228  5.029E+00 0.2079  8.696E-03 0.0004  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.418E-02 0.0014
Th-228  9.209E-01 0.0381  2.442E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.614E-03 0.0001
Th-230  1.401E-02 0.0006  1.412E-02 0.0006  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.511E-02 0.0006
Th-232  2.959E+00 0.1223  7.504E-02 0.0031  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.831E-02 0.0041
U-234   2.277E-04 0.0000  5.684E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.702E-03 0.0003
U-235   4.210E-01 0.0174  5.304E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.299E-03 0.0003
U-238   7.519E-02 0.0031  5.081E-03 0.0002  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.320E-03 0.0003
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   2.277E+01 0.9414  3.995E-01 0.0165  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.438E-01 0.0390
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```
                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                 As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

                                                 Water Dependent Pathways

             Water                  Fish                  Radon                 Plant                  Meat                  Milk             All Pathways*
Radio-  ----------------     ----------------     ----------------     ----------------     ----------------     ----------------     ----------------
Nuclide  mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
------- ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
Ac-227  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.522E+00 0.0629
Co-57   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.632E-03 0.0001
Co-60   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.618E+00 0.1909
Cs-137  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.660E+00 0.0686
H-3     7.543E-02 0.0031    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.543E-02 0.0031
Pb-210  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.737E-01 0.0072
Pu-239  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.156E-01 0.0048
Pu-240  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.155E-01 0.0048
Ra-226  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.200E+00 0.2563
Ra-228  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.072E+00 0.2097
Th-228  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.270E-01 0.0383
Th-230  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.325E-02 0.0018
Th-232  0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.132E+00 0.1295
U-234   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.361E-02 0.0006
U-235   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.336E-01 0.0179
U-238   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.760E-02 0.0036
======= =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======
Total   7.543E-02 0.0031    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.419E+01 1.0000

*Sum of all water independent and dependent pathways.
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                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                    Water Independent Pathways (Inhalation excludes radon)

              Ground             Inhalation             Radon               Plant               Meat                Milk                Soil
Radio-   ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227   7.872E-01 0.0367    2.055E-01 0.0096    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.860E-01 0.0134
Co-57    2.459E-05 0.0000    3.430E-11 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.821E-09 0.0000
Co-60    2.392E+00 0.1116    2.545E-06 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.976E-04 0.0000
Cs-137   1.478E+00 0.0690    1.096E-06 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.086E-03 0.0001
H-3      0.000E+00 0.0000    1.062E-09 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.873E-12 0.0000
Pb-210   2.548E-03 0.0001    7.321E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.450E-01 0.0068
Pu-239   1.668E-04 0.0000    1.857E-02 0.0009    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.685E-02 0.0045
Pu-240   8.623E-05 0.0000    1.856E-02 0.0009    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.678E-02 0.0045
Ra-226   6.096E+00 0.2845    6.337E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.860E-02 0.0041
Ra-228   3.269E+00 0.1526    6.140E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.070E-02 0.0010
Th-228   1.505E-01 0.0070    3.990E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.905E-04 0.0000
Th-230   2.726E-02 0.0013    1.412E-02 0.0007    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.528E-02 0.0007
Th-232   5.471E+00 0.2554    7.960E-02 0.0037    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.147E-01 0.0054
U-234    2.273E-04 0.0000    5.651E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.656E-03 0.0004
U-235    4.185E-01 0.0195    5.285E-03 0.0002    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.295E-03 0.0003
U-238    7.475E-02 0.0035    5.051E-03 0.0002    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.277E-03 0.0003
=======  ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total    2.017E+01 0.9413    3.603E-01 0.0168    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.880E-01 0.0414
```

```
                   Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

                                                     Water Dependent Pathways

            Water                 Fish                 Radon                 Plant                 Meat                  Milk              All Pathways*
Radio-  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------  --------------------
Nuclide  mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
Ac-227   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.279E+00  0.0597
Co-57    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    2.459E-05  0.0000
Co-60    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    2.392E+00  0.1116
Cs-137   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.479E+00  0.0690
H-3      9.601E-03  0.0004    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    9.601E-03  0.0004
Pb-210   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.483E-01  0.0069
Pu-239   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.156E-01  0.0054
Pu-240   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.154E-01  0.0054
Ra-226   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    6.185E+00  0.2887
Ra-228   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    3.296E+00  0.1538
Th-228   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.515E-01  0.0071
Th-230   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    5.666E-02  0.0026
Th-232   0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    5.666E+00  0.2644
U-234    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    1.353E-02  0.0006
U-235    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    4.311E-01  0.0201
U-238    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    8.707E-02  0.0041
=======  =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======    =========  ======
Total    9.601E-03  0.0004    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    0.000E+00  0.0000    2.143E+01  1.0000

*Sum of all water independent and dependent pathways.
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                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                      As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                          Water Independent Pathways (Inhalation excludes radon)

          Ground              Inhalation             Radon                 Plant                 Meat                  Milk                  Soil
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.   mrem/yr    fract.
------- ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227  4.670E-01 0.0255  1.219E-01 0.0067  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.697E-01 0.0093
Co-57   2.006E-11 0.0000  2.799E-17 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.301E-15 0.0000
Co-60   3.324E-01 0.0182  3.537E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.746E-05 0.0000
Cs-137  1.044E+00 0.0571  7.743E-07 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.670E-04 0.0000
H-3     0.000E+00 0.0000  8.171E-18 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.290E-20 0.0000
Pb-210  1.584E-03 0.0001  4.552E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.014E-02 0.0049
Pu-239  1.667E-04 0.0000  1.856E-02 0.0010  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.677E-02 0.0053
Pu-240  8.605E-05 0.0000  1.852E-02 0.0010  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.658E-02 0.0053
Ra-226  5.980E+00 0.3269  8.904E-04 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.402E-01 0.0077
Ra-228  5.648E-01 0.0309  1.088E-03 0.0001  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.490E-03 0.0002
Th-228  6.564E-04 0.0000  1.740E-06 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.576E-06 0.0000
Th-230  6.649E-02 0.0036  1.412E-02 0.0008  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.603E-02 0.0009
Th-232  8.305E+00 0.4540  8.501E-02 0.0046  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.324E-01 0.0072
U-234   2.295E-04 0.0000  5.552E-03 0.0003  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.522E-03 0.0004
U-235   4.112E-01 0.0225  5.245E-03 0.0003  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.306E-03 0.0004
U-238   7.342E-02 0.0040  4.961E-03 0.0003  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.147E-03 0.0004
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   1.725E+01 0.9429  2.763E-01 0.0151  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  7.680E-01 0.0420
```

```
                          Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 2.500E+01 years

                                                      Water Dependent Pathways

                Water                 Fish                 Radon                 Plant                 Meat                  Milk              All Pathways*
Radio-   -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide   mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.     mrem/yr   fract.
-------  ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------    ---------  ------
Ac-227   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.586E-01 0.0415
Co-57    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.007E-11 0.0000
Co-60    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.324E-01 0.0182
Cs-137   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.045E+00 0.0571
H-3      1.980E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.980E-05 0.0000
Pb-210   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.218E-02 0.0050
Pu-239   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.155E-01 0.0063
Pu-240   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.152E-01 0.0063
Ra-226   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.121E+00 0.3346
Ra-228   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.694E-01 0.0311
Th-228   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.607E-04 0.0000
Th-230   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.665E-02 0.0053
Th-232   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.523E+00 0.4659
U-234    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.330E-02 0.0007
U-235    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.238E-01 0.0232
U-238    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.553E-02 0.0047
=======  ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total    1.980E-05 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.829E+01 1.0000

*Sum of all water independent and dependent pathways.
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```
                         Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                         Water Independent Pathways (Inhalation excludes radon)

            Ground              Inhalation             Radon                Plant                Meat                 Milk                 Soil
Radio-  ----------------    ----------------    ----------------    ----------------    ----------------    ----------------    ----------------
Nuclide mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------    --------- ------
Ac-227  2.771E-01 0.0160    7.233E-02 0.0042    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.007E-01 0.0058
Co-57   1.637E-17 0.0000    2.284E-23 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.878E-21 0.0000
Co-60   4.620E-02 0.0027    4.916E-08 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    3.816E-06 0.0000
Cs-137  7.375E-01 0.0426    5.471E-07 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.419E-04 0.0000
H-3     0.000E+00 0.0000    6.219E-26 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.026E-28 0.0000
Pb-210  9.849E-04 0.0001    2.830E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.604E-02 0.0032
Pu-239  1.665E-04 0.0000    1.854E-02 0.0011    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.668E-02 0.0056
Pu-240  8.588E-05 0.0000    1.848E-02 0.0011    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.638E-02 0.0056
Ra-226  5.867E+00 0.3391    1.041E-03 0.0001    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.706E-01 0.0099
Ra-228  9.158E-02 0.0053    1.766E-04 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.655E-04 0.0000
Th-228  2.863E-06 0.0000    7.592E-09 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.124E-08 0.0000
Th-230  1.050E-01 0.0061    1.413E-02 0.0008    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.705E-02 0.0010
Th-232  8.776E+00 0.5073    8.592E-02 0.0050    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.353E-01 0.0078
U-234   2.369E-04 0.0000    5.455E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.390E-03 0.0004
U-235   4.042E-01 0.0234    5.224E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.341E-03 0.0004
U-238   7.211E-02 0.0042    4.873E-03 0.0003    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.021E-03 0.0004
======= ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======    ========= ======
Total   1.638E+01 0.9467    2.265E-01 0.0131    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.955E-01 0.0402
```

```
                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

                                                     Water Dependent Pathways

                 Water               Fish                 Radon                Plant                Meat                 Milk             All Pathways*
Radio-   ------------------- ------------------- -------------------- -------------------- -------------------- -------------------- --------------------
Nuclide   mrem/yr   fract.    mrem/yr   fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  --------- -------  ---------- -------   ---------  -------   ---------- -------   ---------- -------   ---------- -------   ---------- -------
Ac-227   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.501E-01 0.0260
Co-57    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.637E-17 0.0000
Co-60    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.620E-02 0.0027
Cs-137   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    7.381E-01 0.0427
H-3      4.082E-08 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.082E-08 0.0000
Pb-210   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    5.731E-02 0.0033
Pu-239   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.154E-01 0.0067
Pu-240   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.149E-01 0.0066
Ra-226   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    6.038E+00 0.3490
Ra-228   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    9.232E-02 0.0053
Th-228   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    2.882E-06 0.0000
Th-230   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.361E-01 0.0079
Th-232   0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.997E+00 0.5201
U-234    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.308E-02 0.0008
U-235    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    4.167E-01 0.0241
U-238    0.000E+00 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    8.401E-02 0.0049
=======  ========= =======  ========= =======   ========= =======   ========= =======   ========= =======   ========= =======   ========= =======
Total    4.082E-08 0.0000   0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    0.000E+00 0.0000    1.730E+01 1.0000

*Sum of all water independent and dependent pathways.
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                                    Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                    As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                        Water Independent Pathways (Inhalation excludes radon)

                Ground              Inhalation              Radon                 Plant                 Meat                  Milk                  Soil
Radio-   -------------------   -------------------   -------------------   -------------------   -------------------   -------------------   -------------------
Nuclide   mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.     mrem/yr    fract.
-------  ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------     ---------- ------
Ac-227   1.644E-01 0.0098     4.291E-02 0.0026     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     5.972E-02 0.0036
Co-57    1.336E-23 0.0000     1.863E-29 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.532E-27 0.0000
Co-60    6.421E-03 0.0004     6.833E-09 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     5.304E-07 0.0000
Cs-137   5.210E-01 0.0311     3.865E-07 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.828E-04 0.0000
H-3      0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000
Pb-210   6.124E-04 0.0000     1.759E-04 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     3.484E-02 0.0021
Pu-239   1.664E-04 0.0000     1.852E-02 0.0011     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     9.659E-02 0.0058
Pu-240   8.570E-05 0.0000     1.844E-02 0.0011     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     9.619E-02 0.0057
Ra-226   5.755E+00 0.3431     1.125E-03 0.0001     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.879E-01 0.0112
Ra-228   1.482E-02 0.0009     2.858E-05 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     9.154E-05 0.0000
Th-228   1.249E-08 0.0000     3.312E-11 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     4.902E-11 0.0000
Th-230   1.427E-01 0.0085     1.413E-02 0.0008     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.822E-02 0.0011
Th-232   8.852E+00 0.5277     8.606E-02 0.0051     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     1.357E-01 0.0081
U-234    2.493E-04 0.0000     5.360E-03 0.0003     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.261E-03 0.0004
U-235    3.973E-01 0.0237     5.213E-03 0.0003     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     7.387E-03 0.0004
U-238    7.083E-02 0.0042     4.787E-03 0.0003     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     6.896E-03 0.0004
=======  ========= ======     ========= ======     ========= ======     ========= ======     ========= ======     ========= ======     ========= ======
Total    1.593E+01 0.9494     1.968E-01 0.0117     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     0.000E+00 0.0000     6.512E-01 0.0388
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                 Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                           As mrem/yr and Fraction of Total Dose At t = 5.500E+01 years

                                                   Water Dependent Pathways

              Water              Fish              Radon              Plant              Meat               Milk          All Pathways*
Radio-  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------  ----------------
Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
------- --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------  --------- ------
Ac-227  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  2.670E-01 0.0159
Co-57   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.336E-23 0.0000
Co-60   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  6.421E-03 0.0004
Cs-137  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.214E-01 0.0311
H-3     8.416E-11 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.416E-11 0.0000
Pb-210  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.563E-02 0.0021
Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.153E-01 0.0069
Pu-240  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.147E-01 0.0068
Ra-226  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  5.944E+00 0.3544
Ra-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.494E-02 0.0009
Th-228  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.257E-08 0.0000
Th-230  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.751E-01 0.0104
Th-232  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  9.074E+00 0.5410
U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.287E-02 0.0008
U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  4.099E-01 0.0244
U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.251E-02 0.0049
======= ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======  ========= ======
Total   8.416E-11 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  1.677E+01 1.0000

*Sum of all water independent and dependent pathways.
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                                       Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                                    As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                        Water Independent Pathways (Inhalation excludes radon)

              Ground              Inhalation             Radon                 Plant                 Meat                  Milk                  Soil
Radio-  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------  -------------------
Nuclide  mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.    mrem/yr    fract.
-------  ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227   9.751E-02  0.0059   2.546E-02  0.0016   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.543E-02  0.0022
Co-57    1.090E-29  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000
Co-60    8.923E-04  0.0001   9.496E-10  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   7.371E-08  0.0000
Cs-137   3.681E-01  0.0224   2.730E-07  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.705E-04  0.0000
H-3      0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000
Pb-210   3.807E-04  0.0000   1.094E-04  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.166E-02  0.0013
Pu-239   1.662E-04  0.0000   1.851E-02  0.0011   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   9.651E-02  0.0059
Pu-240   8.553E-05  0.0000   1.841E-02  0.0011   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   9.599E-02  0.0058
Ra-226   5.645E+00  0.3437   1.168E-03  0.0001   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.971E-01  0.0120
Ra-228   2.399E-03  0.0001   4.626E-06  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.482E-05  0.0000
Th-228   5.449E-11  0.0000   1.445E-13  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.138E-13  0.0000
Th-230   1.797E-01  0.0109   1.414E-02  0.0009   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.947E-02  0.0012
Th-232   8.864E+00  0.5398   8.609E-02  0.0052   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.358E-01  0.0083
U-234    2.664E-04  0.0000   5.266E-03  0.0003   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   7.134E-03  0.0004
U-235    3.905E-01  0.0238   5.207E-03  0.0003   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   7.439E-03  0.0005
U-238    6.957E-02  0.0042   4.702E-03  0.0003   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.774E-03  0.0004
=======  =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total    1.562E+01  0.9511   1.791E-01  0.0109   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   6.236E-01  0.0380
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                        Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t = 7.000E+01 years

                                                      Water Dependent Pathways

             Water                Fish                Radon                Plant                Meat                 Milk             All Pathways*
Radio-  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------  ------------------
Nuclide  mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.    mrem/yr   fract.
------- ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------   ---------  ------
Ac-227  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.584E-01  0.0096
Co-57   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.090E-29  0.0000
Co-60   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.924E-04  0.0001
Cs-137  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   3.684E-01  0.0224
H-3     1.735E-13  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.735E-13  0.0000
Pb-210  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.215E-02  0.0013
Pu-239  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.152E-01  0.0070
Pu-240  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.145E-01  0.0070
Ra-226  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.843E+00  0.3558
Ra-228  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.419E-03  0.0001
Th-228  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   5.485E-11  0.0000
Th-230  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   2.133E-01  0.0130
Th-232  0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   9.086E+00  0.5533
U-234   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.267E-02  0.0008
U-235   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   4.031E-01  0.0245
U-238   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   8.105E-02  0.0049
======= =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======   =========  ======
Total   1.735E-13  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   0.000E+00  0.0000   1.642E+01  1.0000

*Sum of all water independent and dependent pathways.
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                                Dose/Source Ratios Summed Over All Pathways
                       Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                                     DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)       (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
________ _______  _________    _________ _________ _________ _________ _________ _________ _________ _________

Ac-227   Ac-227   1.000E+00    1.811E+00 1.749E+00 1.522E+00 1.279E+00 7.586E-01 4.501E-01 2.670E-01 1.584E-01

Co-57    Co-57    1.000E+00    2.817E-01 1.106E-01 2.632E-03 2.459E-05 2.007E-11 1.637E-17 1.336E-23 1.090E-29

Co-60    Co-60    1.000E+00    8.915E+00 7.816E+00 4.618E+00 2.392E+00 3.324E-01 4.620E-02 6.421E-03 8.924E-04

Cs-137   Cs-137   1.000E+00    1.864E+00 1.822E+00 1.660E+00 1.479E+00 1.045E+00 7.381E-01 5.214E-01 3.684E-01

H-3      H-3      1.000E+00    2.724E-04 2.716E-02 7.543E-02 9.601E-03 1.980E-05 4.082E-08 8.416E-11 1.735E-13

Pb-210   Pb-210   1.000E+00    2.035E-01 1.972E-01 1.737E-01 1.483E-01 9.218E-02 5.731E-02 3.563E-02 2.215E-02

Pu-239   Pu-239   1.000E+00    1.157E-01 1.157E-01 1.156E-01 1.156E-01 1.155E-01 1.154E-01 1.153E-01 1.152E-01
Pu-239   U-235    1.000E+00    0.000E+00 4.292E-10 2.141E-09 4.268E-09 1.057E-08 1.676E-08 2.283E-08 2.878E-08
Pu-239   Pa-231   1.000E+00    0.000E+00 4.707E-15 1.173E-13 4.673E-13 2.885E-12 7.294E-12 1.362E-11 2.180E-11
Pu-239   Ac-227   1.000E+00    0.000E+00 1.984E-16 2.391E-14 1.828E-13 2.511E-12 9.116E-12 2.117E-11 3.925E-11
Pu-239   ∑DSR(j)               1.157E-01 1.157E-01 1.156E-01 1.156E-01 1.155E-01 1.154E-01 1.153E-01 1.152E-01

Pu-240   Pu-240   1.000E+00    1.156E-01 1.156E-01 1.155E-01 1.154E-01 1.152E-01 1.149E-01 1.147E-01 1.145E-01
Pu-240   U-236    1.000E+00    0.000E+00 3.817E-10 1.903E-09 3.794E-09 9.391E-09 1.488E-08 2.025E-08 2.552E-08
Pu-240   Th-232   1.000E+00    0.000E+00 1.066E-19 2.661E-18 1.062E-17 6.593E-17 1.677E-16 3.149E-16 5.067E-16
Pu-240   Ra-228   1.000E+00    0.000E+00 9.487E-20 1.056E-17 7.382E-17 8.197E-16 2.560E-15 5.331E-15 9.123E-15
Pu-240   Th-228   1.000E+00    0.000E+00 1.371E-20 6.028E-18 6.584E-17 1.068E-15 3.710E-15 8.105E-15 1.424E-14
Pu-240   ∑DSR(j)               1.156E-01 1.156E-01 1.155E-01 1.154E-01 1.152E-01 1.149E-01 1.147E-01 1.145E-01

Ra-226   Ra-226   1.000E+00    6.211E+00 6.203E+00 6.171E+00 6.132E+00 6.014E+00 5.899E+00 5.786E+00 5.675E+00
Ra-226   Pb-210   1.000E+00    0.000E+00 6.223E-03 2.916E-02 5.385E-02 1.073E-01 1.391E-01 1.575E-01 1.675E-01
Ra-226   ∑DSR(j)               6.211E+00 6.209E+00 6.200E+00 6.185E+00 6.121E+00 6.038E+00 5.944E+00 5.843E+00

Ra-228   Ra-228   1.000E+00    3.333E+00 2.952E+00 1.816E+00 9.899E-01 1.602E-01 2.593E-02 4.198E-03 6.794E-04
Ra-228   Th-228   1.000E+00    0.000E+00 1.618E+00 3.256E+00 2.306E+00 4.092E-01 6.638E-02 1.075E-02 1.739E-03
Ra-228   ∑DSR(j)               3.333E+00 4.570E+00 5.072E+00 3.296E+00 5.694E-01 9.232E-02 1.494E-02 2.419E-03

Th-228   Th-228   1.000E+00    5.673E+00 3.949E+00 9.270E-01 1.515E-01 6.607E-04 2.882E-06 1.257E-08 5.485E-11

Th-230   Th-230   1.000E+00    2.981E-02 2.980E-02 2.980E-02 2.980E-02 2.980E-02 2.979E-02 2.979E-02 2.978E-02
Th-230   Ra-226   1.000E+00    0.000E+00 2.689E-03 1.341E-02 2.673E-02 6.619E-02 1.049E-01 1.428E-01 1.800E-01
Th-230   Pb-210   1.000E+00    0.000E+00 1.355E-06 3.245E-05 1.231E-04 6.612E-04 1.471E-03 2.439E-03 3.498E-03
Th-230   ∑DSR(j)               2.981E-02 3.250E-02 4.325E-02 5.666E-02 9.665E-02 1.361E-01 1.751E-01 2.133E-01

Th-232   Th-232   1.000E+00    1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01
Th-232   Ra-228   1.000E+00    0.000E+00 3.784E-01 1.506E+00 2.327E+00 3.150E+00 3.284E+00 3.305E+00 3.309E+00
Th-232   Th-228   1.000E+00    0.000E+00 1.057E-01 1.480E+00 3.193E+00 5.226E+00 5.567E+00 5.622E+00 5.631E+00
Th-232   ∑DSR(j)               1.461E-01 6.302E-01 3.132E+00 5.666E+00 8.523E+00 8.997E+00 9.074E+00 9.086E+00
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                        Dose/Source Ratios Summed Over All Pathways
                 Parent and Progeny Principal Radionuclide Contributions Indicated

Parent   Product  Branch                              DSR(j,t)  (mrem/yr)/(pCi/g)
 (i)      (j)    Fraction* t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
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U-234    U-234    1.000E+00    1.369E-02 1.368E-02 1.361E-02 1.353E-02 1.329E-02 1.305E-02 1.282E-02 1.259E-02
U-234    Th-230   1.000E+00    0.000E+00 2.681E-07 1.337E-06 2.667E-06 6.607E-06 1.048E-05 1.428E-05 1.801E-05
U-234    Ra-226   1.000E+00    0.000E+00 1.210E-08 3.015E-07 1.201E-06 7.414E-06 1.874E-05 3.500E-05 5.600E-05
U-234    Pb-210   1.000E+00    0.000E+00 4.077E-12 4.927E-10 3.782E-09 5.245E-08 1.920E-07 4.491E-07 8.379E-07
U-234    ∑DSR(j)               1.369E-02 1.368E-02 1.361E-02 1.353E-02 1.330E-02 1.308E-02 1.287E-02 1.267E-02

U-235    U-235    1.000E+00    4.361E-01 4.356E-01 4.335E-01 4.309E-01 4.233E-01 4.157E-01 4.083E-01 4.011E-01
U-235    Pa-231   1.000E+00    0.000E+00 9.556E-06 4.755E-05 9.453E-05 2.321E-04 3.647E-04 4.924E-04 6.155E-04
U-235    Ac-227   1.000E+00    0.000E+00 6.025E-07 1.434E-05 5.405E-05 2.849E-04 6.228E-04 1.017E-03 1.437E-03
U-235    ∑DSR(j)               4.361E-01 4.356E-01 4.336E-01 4.311E-01 4.238E-01 4.167E-01 4.099E-01 4.031E-01

U-238    U-238    1.000E+00    8.812E-02 8.802E-02 8.760E-02 8.707E-02 8.553E-02 8.400E-02 8.251E-02 8.104E-02
U-238    U-234    1.000E+00    0.000E+00 3.877E-08 1.929E-07 3.836E-07 9.419E-07 1.480E-06 1.999E-06 2.499E-06
U-238    Th-230   1.000E+00    0.000E+00 3.800E-13 9.470E-12 3.773E-11 2.330E-10 5.893E-10 1.101E-09 1.762E-09
U-238    Ra-226   1.000E+00    0.000E+00 1.145E-14 1.424E-12 1.134E-11 1.747E-10 7.059E-10 1.810E-09 3.680E-09
U-238    Pb-210   1.000E+00    0.000E+00 2.719E-18 1.759E-15 2.718E-14 9.610E-13 5.728E-12 1.871E-11 4.504E-11
U-238    ∑DSR(j)               8.812E-02 8.802E-02 8.760E-02 8.707E-02 8.553E-02 8.401E-02 8.251E-02 8.105E-02
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*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.


                         Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                             Basic Radiation Dose Limit =  10 mrem/yr

Nuclide
  (i)    t= 0.000E+00   1.000E+00   5.000E+00   1.000E+01   2.500E+01   4.000E+01   5.500E+01   7.000E+01
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Ac-227      5.521E+00   5.717E+00   6.571E+00   7.820E+00   1.318E+01   2.222E+01   3.745E+01   6.313E+01
Co-57       3.550E+01   9.040E+01   3.800E+03   4.066E+05   4.984E+11  *8.464E+15  *8.464E+15  *8.464E+15
Co-60       1.122E+00   1.279E+00   2.165E+00   4.181E+00   3.008E+01   2.164E+02   1.557E+03   1.121E+04
Cs-137      5.364E+00   5.490E+00   6.023E+00   6.762E+00   9.572E+00   1.355E+01   1.918E+01   2.715E+01
H-3         3.671E+04   3.682E+02   1.326E+02   1.042E+03   5.052E+05   2.450E+08   1.188E+11   5.763E+13
Pb-210      4.914E+01   5.072E+01   5.757E+01   6.745E+01   1.085E+02   1.745E+02   2.806E+02   4.514E+02
Pu-239      8.646E+01   8.647E+01   8.649E+01   8.651E+01   8.659E+01   8.667E+01   8.674E+01   8.682E+01
Pu-240      8.652E+01   8.653E+01   8.658E+01   8.664E+01   8.682E+01   8.699E+01   8.717E+01   8.735E+01
Ra-226      1.610E+00   1.610E+00   1.613E+00   1.617E+00   1.634E+00   1.656E+00   1.682E+00   1.711E+00
Ra-228      3.000E+00   2.188E+00   1.972E+00   3.034E+00   1.756E+01   1.083E+02   6.692E+02   4.135E+03
Th-228      1.763E+00   2.532E+00   1.079E+01   6.602E+01   1.513E+04   3.469E+06   7.953E+08   1.823E+11
Th-230      3.355E+02   3.077E+02   2.312E+02   1.765E+02   1.035E+02   7.345E+01   5.712E+01   4.688E+01
Th-232      6.846E+01   1.587E+01   3.193E+00   1.765E+00   1.173E+00   1.111E+00   1.102E+00   1.101E+00
U-234       7.303E+02   7.311E+02   7.346E+02   7.389E+02   7.517E+02   7.644E+02   7.770E+02   7.895E+02
U-235       2.293E+01   2.296E+01   2.306E+01   2.320E+01   2.360E+01   2.400E+01   2.440E+01   2.481E+01
U-238       1.135E+02   1.136E+02   1.142E+02   1.148E+02   1.169E+02   1.190E+02   1.212E+02   1.234E+02
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*At specific activity limit
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RESRAD, Version 5.82     T½ Limit = 0.5 year          10/15/99  12:01      Page  52
Summary : SEAD-63 Residential - Site Specific Parameters      File: RESIDENT.RAD

            Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
            and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
         at tmin = time of minimum single radionuclide soil guideline
     and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide  Initial         tmin        DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
  (i)     pCi/g         (years)                   (pCi/g)               (pCi/g)
_______ _________ ________________ ___________ _________ ___________ _________

Ac-227  1.000E+00     0.000E+00     1.811E+00  5.521E+00  1.811E+00  5.521E+00
Co-57   1.000E+00     0.000E+00     2.817E-01  3.550E+01  2.817E-01  3.550E+01
Co-60   1.000E+00     0.000E+00     8.915E+00  1.122E+00  8.915E+00  1.122E+00
Cs-137  1.000E+00     0.000E+00     1.864E+00  5.364E+00  1.864E+00  5.364E+00
H-3     1.000E+00   3.578 ± 0.007   1.352E-01  7.398E+01  2.724E-04  3.671E+04
Pb-210  1.000E+00     0.000E+00     2.035E-01  4.914E+01  2.035E-01  4.914E+01
Pu-239  1.000E+00     0.000E+00     1.157E-01  8.646E+01  1.157E-01  8.646E+01
Pu-240  1.000E+00     0.000E+00     1.156E-01  8.652E+01  1.156E-01  8.652E+01
Ra-226  1.000E+00     0.000E+00     6.211E+00  1.610E+00  6.211E+00  1.610E+00
Ra-228  1.000E+00   3.170 ± 0.006   5.369E+00  1.862E+00  3.333E+00  3.000E+00
Th-228  1.000E+00     0.000E+00     5.673E+00  1.763E+00  5.673E+00  1.763E+00
Th-230  1.000E+00     7.000E+01     2.133E-01  4.688E+01  2.981E-02  3.355E+02
Th-232  1.000E+00     7.000E+01     9.086E+00  1.101E+00  1.461E-01  6.846E+01
U-234   1.000E+00     0.000E+00     1.369E-02  7.303E+02  1.369E-02  7.303E+02
U-235   1.000E+00     0.000E+00     4.361E-01  2.293E+01  4.361E-01  2.293E+01
U-238   1.000E+00     0.000E+00     8.812E-02  1.135E+02  8.812E-02  1.135E+02
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                              Individual Nuclide Dose Summed Over .1 Pathways
                               Parent Nuclide and Branch Fraction Indicated

Nuclide  Parent    BRF(i)                                        DOSE(j,t), mrem/yr
  (j)      (i)              t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______  _______  _________    _________ _________ _________ _________ _________ _________ _________ _________

Ac-227   Ac-227   1.000E+00    1.811E+00 1.749E+00 1.522E+00 1.279E+00 7.586E-01 4.501E-01 2.670E-01 1.584E-01
Ac-227   Pu-239   1.000E+00    0.000E+00 1.984E-16 2.391E-14 1.828E-13 2.511E-12 9.116E-12 2.117E-11 3.925E-11
Ac-227   U-235    1.000E+00    0.000E+00 6.025E-07 1.434E-05 5.405E-05 2.849E-04 6.228E-04 1.017E-03 1.437E-03
Ac-227   ∑DOSE(j):             1.811E+00 1.749E+00 1.522E+00 1.279E+00 7.589E-01 4.507E-01 2.680E-01 1.598E-01

Co-57    Co-57    1.000E+00    2.817E-01 1.106E-01 2.632E-03 2.459E-05 2.007E-11 1.637E-17 1.336E-23 1.090E-29

Co-60    Co-60    1.000E+00    8.915E+00 7.816E+00 4.618E+00 2.392E+00 3.324E-01 4.620E-02 6.421E-03 8.924E-04

Cs-137   Cs-137   1.000E+00    1.864E+00 1.822E+00 1.660E+00 1.479E+00 1.045E+00 7.381E-01 5.214E-01 3.684E-01

H-3      H-3      1.000E+00    2.724E-04 2.716E-02 7.543E-02 9.601E-03 1.980E-05 4.082E-08 8.416E-11 1.735E-13

Pb-210   Pb-210   1.000E+00    2.035E-01 1.972E-01 1.737E-01 1.483E-01 9.218E-02 5.731E-02 3.563E-02 2.215E-02
Pb-210   Ra-226   1.000E+00    0.000E+00 6.223E-03 2.916E-02 5.385E-02 1.073E-01 1.391E-01 1.575E-01 1.675E-01
Pb-210   Th-230   1.000E+00    0.000E+00 1.355E-06 3.245E-05 1.231E-04 6.612E-04 1.471E-03 2.439E-03 3.498E-03
Pb-210   U-234    1.000E+00    0.000E+00 4.077E-12 4.927E-10 3.782E-09 5.245E-08 1.920E-07 4.491E-07 8.379E-07
Pb-210   U-238    1.000E+00    0.000E+00 2.719E-18 1.759E-15 2.718E-14 9.610E-13 5.728E-12 1.871E-11 4.504E-11
Pb-210   ∑DOSE(j):             2.035E-01 2.034E-01 2.029E-01 2.022E-01 2.001E-01 1.979E-01 1.955E-01 1.932E-01

Pu-239   Pu-239   1.000E+00    1.157E-01 1.157E-01 1.156E-01 1.156E-01 1.155E-01 1.154E-01 1.153E-01 1.152E-01

U-235    Pu-239   1.000E+00    0.000E+00 4.292E-10 2.141E-09 4.268E-09 1.057E-08 1.676E-08 2.283E-08 2.878E-08
U-235    U-235    1.000E+00    4.361E-01 4.356E-01 4.335E-01 4.309E-01 4.233E-01 4.157E-01 4.083E-01 4.011E-01
U-235    ∑DOSE(j):             4.361E-01 4.356E-01 4.335E-01 4.309E-01 4.233E-01 4.157E-01 4.083E-01 4.011E-01

Pa-231   Pu-239   1.000E+00    0.000E+00 4.707E-15 1.173E-13 4.673E-13 2.885E-12 7.294E-12 1.362E-11 2.180E-11
Pa-231   U-235    1.000E+00    0.000E+00 9.556E-06 4.755E-05 9.453E-05 2.321E-04 3.647E-04 4.924E-04 6.155E-04
Pa-231   ∑DOSE(j):             0.000E+00 9.556E-06 4.755E-05 9.453E-05 2.321E-04 3.647E-04 4.924E-04 6.155E-04

Pu-240   Pu-240   1.000E+00    1.156E-01 1.156E-01 1.155E-01 1.154E-01 1.152E-01 1.149E-01 1.147E-01 1.145E-01

U-236    Pu-240   1.000E+00    0.000E+00 3.817E-10 1.903E-09 3.794E-09 9.391E-09 1.488E-08 2.025E-08 2.552E-08

Th-232   Pu-240   1.000E+00    0.000E+00 1.066E-19 2.661E-18 1.062E-17 6.593E-17 1.677E-16 3.149E-16 5.067E-16
Th-232   Th-232   1.000E+00    1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01
Th-232   ∑DOSE(j):             1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01 1.461E-01

Ra-228   Pu-240   1.000E+00    0.000E+00 9.487E-20 1.056E-17 7.382E-17 8.197E-16 2.560E-15 5.331E-15 9.123E-15
Ra-228   Ra-228   1.000E+00    3.333E+00 2.952E+00 1.816E+00 9.899E-01 1.602E-01 2.593E-02 4.198E-03 6.794E-04
Ra-228   Th-232   1.000E+00    0.000E+00 3.784E-01 1.506E+00 2.327E+00 3.150E+00 3.284E+00 3.305E+00 3.309E+00
Ra-228   ∑DOSE(j):             3.333E+00 3.330E+00 3.322E+00 3.317E+00 3.311E+00 3.310E+00 3.309E+00 3.309E+00

Th-228   Pu-240   1.000E+00    0.000E+00 1.371E-20 6.028E-18 6.584E-17 1.068E-15 3.710E-15 8.105E-15 1.424E-14
Th-228   Ra-228   1.000E+00    0.000E+00 1.618E+00 3.256E+00 2.306E+00 4.092E-01 6.638E-02 1.075E-02 1.739E-03
Th-228   Th-228   1.000E+00    5.673E+00 3.949E+00 9.270E-01 1.515E-01 6.607E-04 2.882E-06 1.257E-08 5.485E-11
Th-228   Th-232   1.000E+00    0.000E+00 1.057E-01 1.480E+00 3.193E+00 5.226E+00 5.567E+00 5.622E+00 5.631E+00
Th-228   ∑DOSE(j):             5.673E+00 5.673E+00 5.663E+00 5.651E+00 5.636E+00 5.634E+00 5.633E+00 5.633E+00
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                                         Individual Nuclide Dose Summed Over All Pathways
                                           Parent Nuclide and Branch Fraction Indicated

Nuclide Parent   BRF(i)                                          DOSE(j,t), mrem/yr
  (j)     (i)             t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
─────── ─────── ─────────    ───────── ───────── ───────── ───────── ───────── ───────── ───────── ─────────
Ra-226  Ra-226  1.000E+00    6.211E+00 6.203E+00 6.171E+00 6.132E+00 6.014E+00 5.899E+00 5.786E+00 5.675E+00
Ra-226  Th-230  1.000E+00    0.000E+00 2.689E-03 1.341E-02 2.673E-02 6.619E-02 1.049E-01 1.428E-01 1.800E-01
Ra-226  U-234   1.000E+00    0.000E+00 1.210E-08 3.015E-07 1.201E-06 7.414E-06 1.874E-05 3.500E-05 5.600E-05
Ra-226  U-238   1.000E+00    0.000E+00 1.145E-14 1.424E-12 1.134E-11 1.747E-10 7.059E-10 1.810E-09 3.680E-09
Ra-226  ∑DOSE(j):            6.211E+00 6.206E+00 6.185E+00 6.158E+00 6.080E+00 6.004E+00 5.929E+00 5.856E+00

Th-230  Th-230  1.000E+00    2.981E-02 2.980E-02 2,980E-02 2.980E-02 2.980E-02 2.979E-02 2.979E-02 2.978E-02
Th-230  U-234   1.000E+00    0.000E+00 2.681E-07 1.337E-06 2.667E-06 6.607E-06 1.048E-05 1.428E-05 1.801E-05
Th-230  U-238   1.000E+00    0.000E+00 3.800E-13 9.470E-12 3.773E-11 2.330E-10 5.893E-10 1.101E-09 1.762E-09
Th-230  ∑DOSE(j):            2.981E-02 2.981E-02 2.980E-02 2.980E-02 2.980E-02 2.980E-02 2.980E-02 2.980E-02

U-234   U-234   1.000E+00    1.369E-02 1.368E-02 1.361E-02 1.353E-02 1.329E-02 1.305E-02 1.282E-02 1.259E-02
U-234   U-238   1.000E+00    0.000E+00 3.877E-08 1.929E-07 3.836E-07 9.419E-07 1.480E-06 1.999E-06 2.499E-06
U-234   ∑DOSE(j):            1.369E-02 1.368E-02 1.361E-02 1.353E-02 1.329E-02 1.305E-02 1.282E-02 1.259E-02

U-238   U-238   1.000E+00    8.812E-02 8.802E-02 8.760E-02 8.707E-02 8.553E-02 8.400E-02 8.251E-02 8.104E-02
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BRF(i) is the branch fraction of the parent nuclide.
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                                        Individual Nuclide Soil Concentration
                                     Parent Nuclide and Branch Fraction Indicated

Nuclide Parent   BRF(i)                                     S(j,t), pCi/g
  (j)     (i)              t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 2.500E+01 4.000E+01 5.500E+01 7.000E+01
_______ _______ _________     _________ _________ _________ _________ _________ _________ _________ _________

Ac-227  Ac-227  1.000E+00     1.000E+00 9.658E-01 8.403E-01 7.060E-01 4.188E-01 2.485E-01 1.474E-01 8.745E-02
Ac-227  Pu-239  1.000E+00     0.000E+00 1.095E-16 1.320E-14 1.009E-13 1.386E-12 5.033E-12 1.169E-11 2.167E-11
Ac-227  U-235   1.000E+00     0.000E+00 3.326E-07 7.919E-06 2.984E-05 1.573E-04 3.438E-04 5.614E-04 7.935E-04
Ac-227  ∑S(j):                1.000E+00 9.658E-01 8.403E-01 7.061E-01 4.190E-01 2.488E-01 1.480E-01 8.824E-02

Co-57   Co-57   1.000E+00     1.000E+00 3.927E-01 9.344E-03 8.732E-05 7.124E-11 5.812E-17 4.742E-23 3.869E-29

Co-60   Co-60   1.000E+00     1.000E+00 8.767E-01 5.180E-01 2.683E-01 3.729E-02 5.182E-03 7.203E-04 1.001E-04

Cs-137  Cs-137  1.000E+00     1.000E+00 9.771E-01 8.906E-01 7.932E-01 5.604E-01 3.959E-01 2.797E-01 1.976E-01

H-3     H-3     1.000E+00     1.000E+00 2.880E-01 1.982E-03 3.923E-06 3.019E-14 2.298E-22 1.729E-30 1.287E-38

Pb-210  Pb-210  1.000E+00     1.000E+00 9.688E-01 8.535E-01 7.285E-01 4.529E-01 2.816E-01 1.751E-01 1.089E-01
Pb-210  Ra-226  1.000E+00     0.000E+00 3.058E-02 1.433E-01 2.646E-01 5.271E-01 6.833E-01 7.737E-01 8.232E-01
Pb-210  Th-230  1.000E+00     0.000E+00 6.659E-06 1.594E-04 6.048E-04 3.249E-03 7.226E-03 1.199E-02 1.719E-02
Pb-210  U-234   1.000E+00     0.000E+00 2.003E-11 2.421E-09 1.858E-08 2.577E-07 9.435E-07 2.207E-06 4.117E-06
Pb-210  U-238   1.000E+00     0.000E+00 1.336E-17 8.645E-15 1.336E-13 4.722E-12 2.815E-11 9.192E-11 2.213E-10
Pb-210  ∑S(j):                1.000E+00 9.994E-01 9.969E-01 9.937E-01 9.832E-01 9.722E-01 9.607E-01 9.492E-01

Pu-239  Pu-239  1.000E+00     1.000E+00 9.999E-01 9.997E-01 9.994E-01 9.985E-01 9.977E-01 9.968E-01 9.959E-01

U-235   Pu-239  1.000E+00     0.000E+00 9.842E-10 4.909E-09 9.787E-09 2.424E-08 3.842E-08 5.234E-08 6.600E-08
U-235   U-235   1.000E+00     1.000E+00 9.988E-01 9.940E-01 9.881E-01 9.705E-01 9.533E-01 9.363E-01 9.197E-01
U-235   ∑S(j):                1.000E+00 9.988E-01 9.940E-01 9.881E-01 9.705E-01 9.533E-01 9.363E-01 9.197E-01

Pa-231  Pu-239  1.000E+00     0.000E+00 1.041E-14 2.594E-13 1.033E-12 6.379E-12 1.613E-11 3.012E-11 4.820E-11
Pa-231  U-235   1.000E+00     0.000E+00 2.113E-05 1.052E-04 2.090E-04 5.132E-04 8.065E-04 1.089E-03 1.361E-03
Pa-231  ∑S(j):                0.000E+00 2.113E-05 1.052E-04 2.090E-04 5.132E-04 8.065E-04 1.089E-03 1.361E-03

Pu-240  Pu-240  1.000E+00     1.000E+00 9.999E-01 9.993E-01 9.986E-01 9.966E-01 9.946E-01 9.925E-01 9.905E-01

U-236   Pu-240  1.000E+00     0.000E+00 2.958E-08 1.475E-07 2.941E-07 7.279E-07 1.153E-06 1.570E-06 1.978E-06

Th-232  Pu-240  1.000E+00     0.000E+00 7.299E-19 1.821E-17 7.270E-17 4.514E-16 1.148E-15 2.156E-15 3.469E-15
Th-232  Th-232  1.000E+00     1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01
Th-232  ∑S(j):                1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 9.999E-01 9.999E-01

Ra-228  Pu-240  1.000E+00     0.000E+00 2.846E-20 3.167E-18 2.215E-17 2.459E-16 7.680E-16 1.600E-15 2.737E-15
Ra-228  Ra-228  1.000E+00     1.000E+00 8.857E-01 5.450E-01 2.970E-01 4.807E-02 7.781E-03 1.259E-03 2.038E-04
Ra-228  Th-232  1.000E+00     0.000E+00 1.135E-01 4.518E-01 6.980E-01 9.452E-01 9.852E-01 9.917E-01 9.927E-01
Ra-228  ∑S(j):                1.000E+00 9.992E-01 9.968E-01 9.950E-01 9.933E-01 9.930E-01 9.929E-01 9.929E-01

Th-228  Pu-240  1.000E+00     0.000E+00 2.416E-21 1.062E-18 1.161E-17 1.882E-16 6.540E-16 1.429E-15 2.510E-15
Th-228  Ra-228  1.000E+00     0.000E+00 2.852E-01 5.739E-01 4.065E-01 7.212E-02 1.170E-02 1.894E-03 3.066E-04
Th-228  Th-228  1.000E+00     1.000E+00 6.961E-01 1.634E-01 2.670E-02 1.165E-04 5.080E-07 2.216E-09 9.668E-12
Th-228  Th-232  1.000E+00     0.000E+00 1.864E-02 2.609E-01 5.628E-01 9.212E-01 9.813E-01 9.910E-01 9.926E-01
Th-228  ∑S(j):                1.000E+00 9.999E-01 9.981E-01 9.960E-01 9.934E-01 9.930E-01 9.929E-01 9.929E-01
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                                           Individual Nuclide Soil Concentration
                                          Parent Nuclide and Branch Fraction Indicated

Nuclide  Parent    BRF(i)                                              S(j,t), pCi/g
  (j)     (i)              t=  0.000E+00  1.000E+00  5.000E+00  1.000E+01  2.500E+01  4.000E+01  5.500E+01  7.000E+01
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Ra-226   Ra-226   1.000E+00     1.000E+00  9.987E-01  9.936E-01  9.872E-01  9.683E-01  9.498E-01  9.316E-01  9.138E-01
Ra-226   Th-230   1.000E+00     0.000E+00  4.329E-04  2.159E-03  4.304E-03  1.066E-02  1.689E-02  2.300E-02  2.899E-02
Ra-226   U-234    1.000E+00     0.000E+00  1.948E-09  4.854E-08  1.934E-07  1.194E-06  3.018E-06  5.635E-06  9.016E-06
Ra-226   U-238    1.000E+00     0.000E+00  1.844E-15  2.293E-13  1.826E-12  2.813E-11  1.137E-10  2.914E-10  5.925E-10
Ra-226   ∑S(j):                 1.000E+00  9.991E-01  9.957E-01  9.915E-01  9.790E-01  9.667E-01  9.546E-01  9.428E-01

Th-230   Th-230   1.000E+00     1.000E+00  1.000E+00  9.999E-01  9.999E-01  9.997E-01  9.996E-01  9.995E-01  9.993E-01
Th-230   U-234    1.000E+00     0.000E+00  8.996E-06  4.487E-05  8.948E-05  2.217E-04  3.515E-04  4.790E-04  6.042E-04
Th-230   U-238    1.000E+00     0.000E+00  1.275E-11  3.177E-10  1.266E-09  7.817E-09  1.977E-08  3.694E-08  5.912E-08
Th-230   ∑S(j):                 1.000E+00  1.000E+00  1.000E+00  1.000E+00  1.000E+00  1.000E+00  9.999E-01  9.999E-01

U-234    U-234    1.000E+00     1.000E+00  9.988E-01  9.940E-01  9.881E-01  9.705E-01  9.532E-01  9.362E-01  9.195E-01
U-234    U-238    1.000E+00     0.000E+00  2.832E-06  1.409E-05  2.801E-05  6.878E-05  1.081E-04  1.460E-04  1.825E-04
U-234    ∑S(j):                 1.000E+00  9.988E-01  9.940E-01  9.881E-01  9.705E-01  9.533E-01  9.363E-01  9.197E-01

U-238    U-238    1.000E+00     1.000E+00  9.988E-01  9.940E-01  9.881E-01  9.705E-01  9.533E-01  9.363E-01  9.197E-01
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BRF(i) is the branch fraction of the parent nuclide.
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APPENDIX F

APPENDIX F
STREAMLINED RISK EVALUATION

The threat from a site can be quantified through the use of risk assessment techniques. Risk assessments have been performed at several of the higher priority sites and have been a useful tool in evaluating site conditions. Since future land use scenarios have been described as part of the Base Realignment Plan these scenarios have been incorporated into the risk assessment. Risk assessments are appropriate for developing and supporting planning decisions regarding the disposition of the remaining sites that exist at the Seneca Army Depot Activity.

This section of the EE/CA presents the streamlined risk evaluation, or mini-risk assessment, that has been performed for SEAD-63. The risk assessment provides an understanding of the potential threats that this site may pose. The outcome of this evaluation is used to support decisions regarding site disposition. If the site is above the EPA target risk level, it will be considered further. If the site is below these criteria, it may be eliminated from further consideration. Procedures for conducting a mini-risk assessment were presented to EPA and NYSDEC in the Decision Criteria Document dated March 1998.

The methods used to conduct mini-risk assessments for sites at SEDA are the same as those used in prior baseline risk assessments at several of the other sites with the exception that the maximum concentration of a component will be used instead of the Upper 95th Confidence Limit (UCL) of the mean. The reason for using the maximum concentration is that at many of the sites, the existing database is small. Using the maximum detected value will provide an added degree of conservatism. Biased sampling has been performed, and the data represent "worst case" conditions.

The objectives of the mini-risk assessment are:

- to quantify the threat that a site may pose;
- to help determine whether a remedial investigation is necessary;
- to provide a basis for determining if a removal action will eliminate the threat; and
- to help support selection of the "No Action" remedial alternative, where appropriate.

To meet these objectives, the *Risk Assessment Guidance for Superfund* (RAGS) (USEPA, 1989a) was followed when possible and applicable. Technical judgment, consultation with USEPA staff, and recent publications were used in the development of the baseline risk assessment.

SEAD-63, the Miscellaneous Components Burial Site, is shown in **Figure 2-2** of **Section 2** of the EE/CA. The future land use for this site is to be part of a conservation and recreation area.

F.1 Methodology and Organization

The methodology employed for this risk assessment follows USEPA guidance. This section contains seven major subsections, as follows:

1. Identification of Chemicals of Concern (**Section F.2**)

This section provides site-related data along with background chemical data. Detailed summaries and statistical analyses of these data are provided in this section. All chemicals with validated detections in the applicable environmental media were evaluated in the risk assessment. The relevant exposure pathway risks were calculated for each detected chemical. Also included in the Data Evaluation section is an evaluation of site background data. Relevant background data are presented and, where appropriate, statistical analyses were performed to allow for comparing on-site chemical concentrations with background concentrations. Based on these analyses, chemicals whose presence at the site is attributable to background were not further evaluated in the mini-risk assessment.

2. Exposure Assessment (**Section F.3**)

This section includes derivation and presentation of the applicable exposure point concentrations (EPCs) used in the human health risk assessment. Exposure point concentrations for the baseline risk assessment are based on analytical data and modeling results. The EPCs provided are used for future onsite land-use scenarios, and correspond to the applicable exposure pathways for the baseline risk assessment.

For the future on-site land-use scenario, construction workers, park workers, and recreational visitors (child) are the most conservative and relevant exposed populations. In all scenarios, the calculated risk values apply to a hypothetical reasonable maximum exposure (RME) individual working on or visiting the site, and the risk values are dictated by the collected environmental sampling data used in the risk assessment as exposure point concentrations for the applicable media. A residential receptor was also considered for comparative purposes only. Future residential use of the land is highly unlikely.

The three primary exposure routes considered in the baseline risk assessment are ingestion, inhalation, and dermal contact. Chemical intake values for future land use are calculated based on exposure pathways, specific exposure values, and assumptions. Equations used to calculate intakes for all applicable exposure pathways are presented in this section.

3. Toxicity Assessment (**Section F.4**)

This section presents oral, inhalation, and dermal toxicity values used in the human health risk calculations. Appropriate data sources (i.e., IRIS, HEAST and EPA Risk Assessment Issue papers) are provided to support the toxicity values.

4. Risk Characterization (**Section F.5**)

This section presents the risk calculations for all human health exposure pathways for the expected future land use. Non-carcinogenic and carcinogenic risk estimates are summarized for each receptor and exposure pathway.

F.2 Identification of Chemicals of Concern

Data collected were evaluated for suitability of use in the risk assessment as discussed in RAGS (EPA, 1989a). These decisions were based on analytical methods, quantitation limits, qualifiers, and blank contamination.

The data usability criteria for documentation, analytical methods, data validation, precision, accuracy, representativeness, comparability, and completeness are discussed below in Section F.2.1.

A portion of the data used in the mini-risk assessment were collected during ESI field investigation conducted in June through July 1994 and documented in the report cited in the last paragraph. Additional data for surface water and sediment were collected in the fall, 1997 and are presented in **Section 2** of this report.

Twelve subsurface soil, 22 sediment and 22 surface water samples were collected at SEAD-63. Groundwater samples were collected from the three monitoring wells, which were installed at SEAD-63 during the RI.

The following sections describe the processes by which the data were analyzed, examined, and reduced to arrive at a list of analytes, for each exposure pathway, that were quantified for use in the human health mini-risk assessment.

F2.1 Data Usability

The data usability criteria for documentation, analytical methods, data validation, precision, accuracy, representativeness, comparability, and completeness are discussed in this section.

The RI data were collected during two investigations, the SEAD-63 ESI and the SEAD-63 RI. The ESI began in the late spring/early summer (i.e., June/July) of 1994 and the RI was conducted in December of 1997.

The data used for the risk assessment were grouped into six databases, one for each of the exposure route/exposure scenarios that were developed from the exposure point pathway models. Individual databases contained data specific to one of the following sample combinations: surface soils (defined as soil samples collected from 0 to 2 inches below grade) only, surface and subsurface soils (i.e. all soils data), groundwater, surface water, and sediments for the human health risk assessment and a combined surface soils/sediment sample to a depth of two feet for the ecological risk assessment

The following sections describe the processes by which the data were analyzed, examined, and reduced to arrive at a list of analytes and their representative concentrations, for each exposure pathway addressed in the baseline human health and ecological risk assessments.

F2.1.1 Documentation

Documentation of sample collection and laboratory analysis is essential in order to authenticate conclusions derived from data. Standard operating procedures (SOPs) for field collection of samples are provided in the generic workplan, and were followed during sample collection. Formal chain-of-custody records that included sample identifications (IDs), date sampled, sample collector, analyses and methods required, matrix, preservation per analysis, and comments were maintained.

Laboratory SOPs were used for all analyses required. Deviations from these SOPs were documented in case narratives that were part of each sample delivery group (SDG). Deviations from these SOPs were minor and did not adversely affect data quality.

F2.1.2 Evaluation of Analytical Methods

All data used in the risk assessment were generated using level IV CLP protocols. The CLP was developed to ensure that consistent QA/QC methods are used when evaluating samples from

Superfund site. However, this does not mean that all CLP data are automatically of sufficient quality and reliability for use in the quantitative risk assessment.

The data used in this baseline risk assessment were validated in compliance with EPA Region II validation guidelines. The following criteria were considered and used to validate the data: spike/matrix spike duplicates, field duplicates, internal standard performance, compound identification, compound quantitation, spike sample recovery for metals, laboratory duplicates for metals, interference for metals, and qualifiers. Several steps were taken to ensure that the data were appropriate and reliable for use in the risk assessment. These steps, such as evaluation of quantitation limits, are discussed in the following sections.

F.2.1.3 Evaluation of Qualified and Coded Data

Qualifiers are attached to analytical data by personnel of the laboratory performing the analysis or by data validation personnel. These qualifiers often pertain to QA/QC problems and may indicate questions concerning chemical identity, chemical concentration, or both. The qualifiers used are as follows:

U	The analyte was not detected.
UJ	The analyte was not detected; however, the associated reporting limit is approximate.
J	The analyte was positively identified; however, QC results indicate that the reported concentration may not be accurate and is therefore an estimate.
R, JR, UR	The analyte was rejected due to laboratory QC deficiencies, sample preservation problems, or holding time exceedance. The presence or absence of the analyte cannot be determined.

Before data were used in the quantitative risk assessment all qualifiers were addressed. This was done according to the prescribed data validation procedures. The end result of the data validation was four possible situations:

1) the result was rejected by either laboratory or data validation personnel and considered unusable (R, JR, UR),
2) the compound was analyzed for but was not detected (U),
3) the result was an estimated value (J), or

4) the result was unqualified.

Data that was not detected by the laboratory (U) and was assigned a J by the data validation personnel is considered a non-detect for the risk assessment (UJ).

F2.1.4 Chemicals in Blanks

Blanks are QC samples analyzed in the same manner as environmental samples, and provide a means of identifying possible contamination of environmental samples. Sources of contamination include the laboratory, the sampling environment, and the sampling equipment. To address contamination, three types of blanks were analyzed: method blanks, trip blanks, and equipment rinsates. Method blanks consisted of laboratory reagent water or pre-purified and extracted sand taken through the same analytical process as environmental samples. Trip blanks consisted of distilled water poured into a 40-milliliter glass vial and sealed with a Teflon septum for soil and water samples. The trip blanks accompanied sample bottles to the field during sample collection. Trip blanks were not opened during sample collection. Equipment rinsates consisted of deionized water poured into or pumped through sampling devices and then transferred to sample bottles.

According to the data validation guidelines, if the blank contained detectable levels of a common laboratory contaminant, then the sample results were considered positive (unqualified hit) only if the concentration in the sample exceeded ten times the maximum amount detected in any blank. If the concentration in the sample was less than ten times the maximum amount detected in the blank, it was concluded that the chemical was not detected. Common laboratory contaminants are acetone, 2-butanone, methylene chloride, toluene, and phthalate esters. If the blank contained detectable levels of a chemical that is not a common laboratory contaminant, then the sample results were considered positive (unqualified hit) only if the concentration in the sample exceeded five times the maximum amount detected in any blank. If the concentration in the sample was less than five times the maximum amount detected in the blank, it was concluded that the chemical was not detected. This procedure was performed as part of the data validation.

F2.1.5 Precision

The term precision is used to describe the reproducibility of results. It can be defined as the agreement between the numerical values of two or more measurements resulting from the same process. In the case of chemical analyses, precision is determined through the analyses of duplicate environmental samples. Duplicate sample analyses include matrix spikes, blank spikes, blind field duplicates, and replicate instrumental analyses of individual environmental samples.

Matrix spikes involve the introduction of compounds or elements to samples of known concentrations. The assumption is that these introduced compounds will be recovered from environmental samples to the same degree as in matrix spikes. Blank spikes involve the introduction of compounds or elements to laboratory reagent water or pre-purified and extracted sand. Blank spikes eliminate the possibility of matrix interference's or contributions, thereby monitoring analytical performance from sample preparation to analysis. Blind field duplicates are samples labeled with a fictitious sample ID taken from an existing sampling location. They are collected simultaneously with a properly labeled sample and provide the most legitimate means of assessing precision.

Precision estimates were obtained using the relative percent difference (RPD) between duplicate analyses. Overall precision, as well as precision control limits, was estimated using a weighted combination of RPDs from spikes and duplicate analyses. Precision and RPD were acceptable.

F2.1.6 Accuracy

Accuracy is the degree to which a measurement represents the true value of that parameter. Estimates of accuracy are more difficult to obtain than precision since accuracy requires knowledge of the true quantity being measured. In the case of chemical analyses, accuracy is determined through the introduction of compounds or elements to samples of known concentrations, or analytical spikes. The assumption is that compounds will be recovered from environmental samples to the same degree as in analytical spikes.

Two types of compounds were added to environmental samples to assess accuracy: surrogate compounds and matrix spike compounds. Surrogates are compounds that closely approximate target analytes in structure, but are not target analytes. Surrogate compounds generally are added to samples in the preparation stages and monitor the effectiveness of the preparation process. Matrix spike compounds are target analytes that are added based upon expectations of matrix interference's, that impede analyte detection. Laboratory method blank samples were spiked with surrogate compounds, per analysis day, as an additional means of estimating accuracy. The accuracy of chemical analyses was estimated using the percent recovery (PR) of compounds or elements that were added to analytical spikes. Accuracy and PR were acceptable.

F2.1.7 Representativeness

Representativeness expresses the extent to which sample data characterize the population or environmental media. Factors influencing representativeness include sample collection, selection of sampling locations representative of site conditions, and use of appropriate chemical methods for sample analyses. Appropriate chemical analysis methods were followed as described in **Section F2.1.2**. Sampling from locations representative of site conditions was achieved through implementation of the approved field sampling plan. Blind field duplicates were collected and analyzed in order to assess the influence of sample collection on representativeness. Approximately 5 percent of field samples were collected in duplicate. Representativeness was estimated using the RPD between blind field duplicates and was acceptable.

F2.1.8 Comparability

Comparability refers to the consistency of one laboratory's results with others. Comparability factors include the use of standard analytical methodologies, data reported in standard or consistent units, appropriate frequency of applicable QC analyses, and laboratory participation in appropriate performance evaluation studies. All data were reported in appropriate and acceptable units. The laboratory performing the CLP inorganic and organic analyses participated in the quarterly USEPA blind performance evaluation program and the MRD performance evaluation program. Their performance in this program was acceptable.

F2.1.9 Completeness

Completeness measures the amount of usable data relative to the amount of samples collected and analyzed. The completeness goal in the project workplan was 90 percent. Completeness was acceptable.

F.2.2 Site-Specific Data Evaluation Considerations

The maximum concentration of a component in the database was used as the exposure point concentration in the mini-risk assessment.

NYSDEC CLP Statement of Work methods were used for the analysis of organic and inorganic constituents in soil and groundwater. These methods provide data suitable for the mini-risk assessment.

For inorganics, the site data set was compared against the SEDA background dataset to determine if the site data set is statistically different from the background dataset. This background comparison was performed for two media: soil and groundwater.

For each inorganic constituent, the average concentration for the site was compared to 2 times the average background concentration. If the site average concentration for a constituent was less than 2 times the background average concentration, the constituent was considered to be present due to background conditions, and it was eliminated from further consideration in the risk assessment. USEPA Region 2 recommended this comparison method.

Removing analytes from further consideration is consistent with RAGS (EPA 1989a). Inorganic constituents that were not detected were not considered; these were eliminated from further consideration as is consistent with RAGS (EPA, 1989a).

Only inorganic constituents were compared to background. Anthropogenic organic constituents have not been considered. Organic compounds were eliminated from further consideration only if they were not detected at a particular site. This has produced a more conservative risk assessment since all organic constituents have been assumed to be present due to previous site activities. Background data sets are provided in **Appendix D**.

Two inorganic analytes were found to occur in the SEAD-63 soil dataset at average concentrations that were greater than twice the average for those observed in the background soil measurements. They are cadmium and mercury. These inorganic constituents in soil were retained for further analysis in the mini-risk assessment performed for SEAD-63.

For the groundwater samples, two inorganic analytes, sodium and manganese, were found to occur in the groundwater dataset at an average concentration that was twice the background average. These inorganic constituents in groundwater were retained for further analysis in the mini-risk assessment performed for SEAD-63.

Although samples of sediment have been collected from the drainage ditches that surround and transect portions of SEAD-63, these samples have been treated as shallow soil samples within the ecological mini risk assessments. Generally, the drainage ditches in the area of SEAD-63 are dry except when they carry storm-water runoff; thus, these areas are unlikely to support any form of aquatic or amphibian life. To assess the potential effect of chemicals identified in "sediment" at SEAD-63 therefore, this dataset has been used to augment the shallow soil dataset that is used for the evaluation of potential impacts on the mammalian and avian receptors. The combined shallow soil/sediment dataset is presented in **Table F-1**.

Tables F-2 and **F-3** summarize the results of average comparisons for the soil dataset and the groundwater dataset, respectively. **Table F-4** summarizes the result of the average comparison for the combined shallow soil/sediment data set that has been used for the ecological risk assessment only.

F.2.3 Data Quantification for Use in the Risk Assessment

After eliminating inorganic analytes present at background levels from the risk assessment, exposure point concentrations (EPCs) were selected as the maximum detected value for each constituent of concern. When the maximum value occurred in a sample that had a duplicate sample, the maximum value was used in the risk assessment, i.e., the samples were not averaged.

Table F-5 lists the chemicals of potential concern for the mini-risk assessment for SEAD-63 in all soils and groundwater, less the inorganic analytes found at background levels. The number of analyses performed, the number of times detected, the frequency of detection, and the maximum detected concentration for each chemical of potential concern are provided in the data tables presented in **Section 2** of **Appendix A** and in **Table F-1** for the combined shallow soil/sediment dataset used for the ecological risk assessment.

F.3 Exposure Assessment

F.3.1 Overview and Characterization of Exposure Setting

The objective of the exposure assessment was to estimate the type and magnitude of exposures to the Chemicals of Potential Concern (COPC) that are present at, or migrating from, the site. This component of the risk assessment can be performed either qualitatively or quantitatively. Quantitative assessment is preferred when toxicity factors necessary to characterize a compound of concern are available.

The exposure assessment consists of three steps (EPA, 1989a):

1) **Characterize Exposure Setting:** In this step, information on the physical characteristics of the site that may influence exposure is considered. The physical setting involves

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RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

							Matrix	SOIL		SOIL		SOIL		SOIL		SOIL		SEDIMENT	
							Area	SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
							Sample Depth (ft)	2		2		1.5		1.5		1.5		0.05	
							Sample Date	06/26/94		06/26/94		06/27/94		06/27/94		06/28/94		13-Jun-94	
							Location	TP63-2		TP63-5		TP63-7		TP63-8		TP63-10		SD63-1	
							Sample Number	225561		225564		225566		225596		225803			
							SDG	45062		45062		45062		45062		45062			
Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds																			
Acetone	ug/Kg	150	29.8%	200	0	8	27	12	U	12	U	12	U	12	U	12	U	15	U
2-Butanone	ug/Kg	35	7.4%	300	0	2	27	12	U	12	U	12	U	12	U	12	U	15	U
Benzene	ug/Kg	2	20 0%	60	0	1	5	12	U	12	U	12	U	2	J	12	U		
Toluene	ug/Kg	14	7.4%	1500	0	2	27	12	U	12	U	12	U	6	J	12	U	15	U
Xylene (total)	ug/Kg	14	20.0%	1200	0	1	5	12	U	12	U	12	U	14		12	U		
SemiVolatile Organic Compounds																			
2-Methylnaphthalene	ug/Kg	14	9.1%	36400	0	2	22											480	U
Benzo(a)anthracene	ug/Kg	2000	77.8%	224	3	21	27	390	U	410	U	380	U	390	U	410	U	69	J
Benzo(a)pyrene	ug/Kg	2700	81.5%	61	12	22	27	390	U	410	U	380	U	24	J	410	U	[illegible]	J
Benzo(b)fluoranthene	ug/Kg	3500	81.5%	1100	2	22	27	390	U	410	U	380	U	21	J	410	U	130	J
Benzo(k)fluoranthene	ug/Kg	1900	63.0%	1100	1	17	27	390	U	410	U	380	U	21	J	410	U	89	J
bis(2-Ethylhexyl)phthalate	ug/Kg	1800	63.0%	50000	0	17	27	290	J	1800	J	80	J	71	J	67	J	25	J
Butylbenzylphthalate	ug/Kg	120	27.3%	50000	0	6	22											480	U
Carbazole	ug/Kg	430	45.5%		0	10	22											480	U
Chrysene	ug/Kg	2200	81.5%	400	3	22	27	390	U	410	U	380	U	23	J	410	U	110	J
Di-n-butylphthalate	ug/Kg.	120	25.9%	8100	0	7	27	390	U	410	U	380	U	390	U	410	U	480	U
Di-n-octylphthalate	ug/Kg	19	4.5%	50000	0	1	22											480	U
Dibenz(a,h)anthracene	ug/Kg	1200	40.7%	14	9	11	27	390	U	410	U	380	U	390	U	410	U	480	U
Dibenzofuran	ug/Kg	36	9.1%	6200	0	2	22											480	U
Diethyl phthalate	ug/Kg	92	40.9%	7100	0	9	22											480	U
Fluoranthene	ug/Kg	4300	81.5%	50000	0	22	27	390	U	410	U	380	U	38	J	410	U	110	J
Fluorene	ug/Kg	110	13.6%	50000	0	3	22											480	U
Indeno(1,2,3-cd)pyrene	ug/Kg	2500	77.8%	3200	0	21	27	390	U	410	U	380	U	390	U	410	U	46	J
Naphthalene	ug/Kg	23	9.1%	13000	0	2	22											480	U
Phenanthrene	ug/Kg	1500	81.5%	50000	0	22	27	390	U	410	U	380	U	390	U	410	U	49	J
Phenol	ug/Kg	93	4.5%	30	1	1	22											480	U
Pyrene	ug/Kg	3200	95.5%	50000	0	21	22											100	J
Organochlorine Pesticides																			
4,4'-DDE	ug/Kg	3.9	3.7%	2100	0	1	27	3.9	UJ	4.1	UJ	3.8	UJ	3.9	UJ	4.1	U	4.9	UJ
4,4'-DDD	ug/Kg	9.2	11.1%	2900	0	3	27	3.9	UJ	4.1	UJ	3.8	UJ	3.9	UJ	4.1	U	4.9	UJ
4,4'-DDT	ug/Kg	8.3	7.4%	2100	0	2	27	3.9	UJ	4.1	UJ	3.8	UJ	3.9	UJ	4.1	U	4.9	UJ
Endosulfan I	ug/Kg	7.5	9.1%	900	0	2	22											2.5	UJ
Endosulfan sulfate	ug/Kg	5.2	4.5%	1000	0	1	22											4.9	UJ
Endrin ketone	ug/Kg	9.4	4.5%		0	1	22											4.9	UJ

TABLE F-1

RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

						Matrix		SOIL		SOIL		SOIL		SOIL		SOIL		SEDIMENT	
						Area		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
						Sample Depth (ft)		2		2		1.5		1.5		1.5		0.05	
						Sample Date		06/26/94		06/28/94		06/27/94		06/27/94		06/28/94		13-Jun-94	
						Location		TP63-2		TP63-5		TP63-7		TP63-8		TP63-10		SD63-1	
						Sample Number		225561		225564		225566		225596		225803			
						SDG		45062		45062		45062		45062		45062			
Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds																			
Metals/Cyanide																			
Aluminum	mg/Kg	18000	100.0%	20650	0	27	27	14800	J	15300	J	11700	J	16500	J	18000	J	7590	
Antimony	mg/Kg	0.23	20.0%	6.27	0	1	5	0.26	UJ	0.27	UJ	0.23	J	0.3	UJ	0.31	UJ		
Arsenic	mg/Kg	6.8	100.0%	9.6	0	27	27	5.4		4.9		4.2		5.2		5.3		4.1	
Barium	mg/Kg	107	100.0%	300	0	27	27	65.3	J	75.4	J	45.8	J	59.5	J	72.4	J	36.3	J
Beryllium	mg/Kg	0.8	100.0%	1.13	0	27	27	0.74	J	0.69	J	0.54	J	0.64	J	0.71	J	0.44	J
Cadmium	mg/Kg	0.83	33.3%	2.46	0	9	27	0.26	J	0.52	J	0.56	J	0.24	J	0.39	J	0.6	J
Calcium	mg/Kg	211000	100.0%	125300	2	27	27	3830	J	40500	J	39800	J	5440	J	14200	J	101000	
Chromium	mg/Kg	24.6	100.0%	30.95	0	27	27	22.9	J	23.2	J	19.1	J	21.5	J	24.6	J	13.8	J
Cobalt	mg/Kg	14.4	100.0%	30	0	27	27	11.6		12.4		10.7		9.7	J	12.7		10.6	J
Copper	mg/Kg	42.6	100.0%	32.94	5	27	27	27.1	J	35.1	J	34.3	J	20.2	J	27.3	J	25.2	
Cyanide	mg/Kg	2.1	4.5%	0.35	1	1	22											0.6	U
Iron	mg/Kg	30100	100.0%	38110	0	27	27	30100	J	28100	J	25000	J	25000	J	28500	J	17100	
Lead	mg/Kg	46.2	85.2%	23.49	9	23	27	18.5		22.3		15.6		15.5		17.1		33.5	R
Magnesium	mg/Kg	16100	100.0%	21890	0	27	27	4530	J	8310	J	8160	J	4400	J	5520	J	15000	
Manganese	mg/Kg.	995	100.0%	1095	0	27	27	278	J	403	J	359	J	350	J	452	J	449	
Mercury	mg/Kg	0.13	44.0%	0.1	2	11	25	0.05	J	0.06	J	0.04	J	0.06	J	0.05	J	0.04	J
Nickel	mg/Kg	44.2	103.8%	52.58	0	27	26	31.5	J	42	J	39.1	J	23.9	J	33.5	J	29.8	
Potassium	mg/Kg	2570	100.0%	2623	0	27	27	1180	J	2150	J	1310	J	1530	J	2000	J	1370	J
Selenium	mg/Kg	2.1	40.7%	2	1	11	27	1.5		1.5		0.74		1.3		1.1	J	0.62	U
Sodium	mg/Kg	578	81.5%	187.8	15	22	27	50.8	J	138	J	124	J	50.6	J	46.7	U	121	J
Thallium	mg/Kg	2.3	14.8%	0.28	4	4	27	0.38	U	1.04	J	0.29	J	0.44	U	0.45	U	0.44	U
Vanadium	mg/Kg	28.4	100.0%	150	0	27	27	25.2	J	22.4	J	16.8	J	27.6	J	28.4	J	19.9	
Zinc	mg/Kg	534	100.0%	115	7	27	27	74.8	J	88.9	J	95.7	J	68.6	J	63.4	J	105	
Others																			
Total Solids	%W/W	85.8	100.0%		0	5	5	83.7		81.2		85.8		85.2		79.6			

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RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

						Matrix		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
						Area		SEAD-83		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
						Sample Depth (ft)		0.05		0.05		0 05		0.8		0.8		0 6	
						Sample Date		12-Jun-94		13-Jun-94		13-Jun-94		4-Dec-97		4-Dec-97		5-Dec-97	
						Location		SD63-2		SD83-3		SD83-4		63101		12215		63102	
						Sample Number													
						SDG													
Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds																			
Acetone	ug/Kg	150	29.6%	200	0	8	27	23	UJ	12	UJ	150	J	16		18	U	14	U
2-Butanone	ug/Kg	35	7.4%	300	0	2	27	8	J	12	UJ	35	J	16	U	18	U	14	U
Benzene	ug/Kg	2	20.0%	60	0	1	5												
Toluene	ug/Kg	14	7.4%	1500	0	2	27	18	UJ	12	UJ	14	J	16	U	18	U	14	U
Xylene (total)	ug/Kg	14	20.0%	1200	0	1	5												
SemiVolatile Organic Compounds																			
2-Methylnaphthalene	ug/Kg	14	9.1%	36400	0	2	22	700	UJ	390	U	720	UJ	120	U	120	U	88	U
Benzo(a)anthracene	ug/Kg	2000	77.8%	224	3	21	27	140	J	70	J	350	J	13	U	14	J	51	J
Benzo(a)pyrene	ug/Kg	2700	81.5%	61	12	22	27	170	J	72	J	540	J	21	U	23	J	58	J
Benzo(b)fluoranthene	ug/Kg	3500	81.5%	1100	2	22	27	380	J	110	J	860	J	37	U	39	JY	120	Y
Benzo(k)fluoranthene	ug/Kg	1900	63 0%	1100	1	17	27	180	J	66	J	470	J	120	U	120	U	88	U
bis(2-Ethylhexyl)phthalate	ug/Kg	1800	63.0%	50000	0	17	27	700	UJ	390	U	720	UJ	25	U	21	JB	110	B
Butylbenzylphthalate	ug/Kg	120	27.3%	50000	0	6	22	700	UJ	390	U	720	UJ	22	J	19	J	88	U
Carbazole	ug/Kg	430	45.5%		0	10	22	700	UJ	390	U	34	J	120	U	120	U	9.4	J
Chrysene	ug/Kg	2200	81.5%	400	3	22	27	200	J	110	J	[illegible]	J	13	U	14	J	73	J
Di-n-butylphthalate	ug/Kg.	120	25.9%	8100	0	7	27	700	UJ	390	U	720	UJ	14	J	19	JB	18	JB
Di-n-octylphthalate	ug/Kg	19	4.5%	50000	0	1	22	700	UJ	19	J	720	UJ	120	U	120	U	88	U
Dibenz(a,h)anthracene	ug/Kg	1200	40.7%	14	9	11	27	700	UJ	390	U	140	J	120	U	8.7	U	[illegible]	J
Dibenzofuran	ug/Kg	36	9.1%	8200	0	2	22	700	UJ	390	U	720	UJ	120	U	120	U	88	U
Diethyl phthalate	ug/Kg	92	40.9%	7100	0	9	22	700	UJ	390	U	720	UJ	120	U	7.4	JB	4.7	JB
Fluoranthene	ug/Kg	4300	81.5%	50000	0	22	27	240	J	100	J	720	J	32	U	32	J	100	
Fluorene	ug/Kg	110	13.6%	50000	0	3	22	700	UJ	390	U	720	UJ	120	U	120	U	86	U
Indeno(1,2,3-cd)pyrene	ug/Kg	2500	77.8%	3200	0	21	27	83	J	42	J	320	J	12	U	14	J	37	J
Naphthalene	ug/Kg	23	9.1%	13000	0	2	22	700	UJ	390	U	720	UJ	120	U	120	U	88	U
Phenanthrene	ug/Kg	1500	81.5%	50000	0	22	27	120	J	50	J	270	J	14	J	16	J	51	J
Phenol	ug/Kg	93	4.5%	30	1	1	22	700	UJ	390	U	720	UJ	120	U	120	U	88	U
Pyrene	ug/Kg	3200	95.5%	50000	0	21	22	220	J	110	J	600	J	23	U	23	J	80	J
Organochlorine Pesticides																			
4,4'-DDE	ug/Kg	3.9	3.7%	2100	0	1	27	7	UJ	3.9	UJ	3.9	J	6.2	U	6.1	U	4.4	U
4,4'-DDD	ug/Kg	9.2	11.1%	2900	0	3	27	6	J	3.9	UJ	9.2	J	6.2	U	6.1	U	4.4	U
4,4'-DDT	ug/Kg	8.3	7.4%	2100	0	2	27	7	UJ	3.9	UJ	4.3	J	6.2	U	6.1	U	4.4	U
Endosulfan I	ug/Kg	7.5	9.1%	900	0	2	22	7.5	J	4.6	J	3.7	UJ	3.2	U	3.1	U	2.3	U
Endosulfan sulfate	ug/Kg	5.2	4.5%	1000	0	1	22	7	UJ	3.9	UJ	5.2	J	6.2	U	6.1	U	4.4	U
Endrin ketone	ug/Kg	9.4	4.5%		0	1	22	7	UJ	3.9	UJ	9.4	J	6.2	U	6.1	U	4.4	U

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RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

							Matrix	SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
							Area	SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
							Sample Depth (ft)	0.05		0.05		0.05		0.8		0.8		0.6	
							Sample Date	12-Jun-94		13-Jun-94		13-Jun-94		4-Dec-97		4-Dec-97		5-Dec-97	
							Location	SD63-2		SD63-3		SD63-4		63101		12215		63102	
							Sample Number												
							SDG												
Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds																			
Metals/Cyanide																			
Aluminum	mg/Kg	18000	100.0%	20650	0	27	27	11700	J	11100		11000	J	9770	*	16700	*	2030	*
Antimony	mg/Kg	0.23	20.0%	6.27	0	1	5												
Arsenic	mg/Kg	6.8	100.0%	9.6	0	27	27	3.7	J	4.3		2.4	J	2.9		5.2		2.3	B
Barium	mg/Kg	107	100.0%	300	0	27	27	63.5	J	37.2		90.6	J	88.1		107		19.9	B
Beryllium	mg/Kg	0.8	100.0%	1.13	0	27	27	0.59	J	0.52	J	0.54	J	0.51	B	0.8	B	0.11	B
Cadmium	mg/Kg	0.83	33.3%	2.46	0	9	27	0.83	J	0.38	J	0.68	J	0.08	U	0.08	U	0.08	U
Calcium	mg/Kg	211000	100.0%	125300	2	27	27	89800	J	31500		34100	J	2090		3080	*	139000	*
Chromium	mg/Kg	24.6	100.0%	30.95	0	27	27	19.1	J	20.3	J	18.2	J	15	*	23.4	*	4.1	*
Cobalt	mg/Kg	14.4	100.0%	30	0	27	27	11.9	J	11.2		10.5	J	7.9		10.7	B	3.2	B
Copper	mg/Kg	42.6	100.0%	32.94	5	27	27	[illegible]	J	32.7		30.7	J	15.9		24		8.7	
Cyanide	mg/Kg	2.1	4.5%	0.35	1	1	22	0.97	UJ	0.53	U	0.99	UJ	1.1	UJ	1.1	UN	[illegible]	N
Iron	mg/Kg	30100	100.0%	38110	0	27	27	19200	J	26500		18700	J	16300		24400	*	4790	*
Lead	mg/Kg	46.2	85.2%	23.49	9	23	27	37.4	R	27.5	R	37.2	R	17.6	*	[illegible]	N*	8.6	N*
Magnesium	mg/Kg	16100	100.0%	21890	0	27	27	13900	J	6210		8590	J	2610	*	4090	*	9380	*
Manganese	mg/Kg	995	100.0%	1095	0	27	27	653	J	280		801	J	431	J	536	*	225	*
Mercury	mg/Kg	0.13	44.0%	0.1	2	11	25	0.06	J	0.03	J	0.12	J	0.08	U	0.07	BN	0.05	UN
Nickel	mg/Kg	44.2	103.6%	52.58	0	27	26	35	J	44.2		32.8	J	18.4		29.5	*	8.8	B*
Potassium	mg/Kg	2570	100.0%	2623	0	27	27	2570	J	1340	J	1670	J	1120		1830	B	597	B
Selenium	mg/Kg	2.1	40.7%	2	1	11	27	0.68	UJ	1.1		0.97	J	1.2	U	1.3	U	1.2	U
Sodium	mg/Kg	578	81.5%	187.8	15	22	27	194	J	[illegible]	J	119	J	234	U	[illegible]	B	[illegible]	B
Thallium	mg/Kg	2.3	14.8%	0.28	4	4	27	0.46	UJ	0.34	U	0.62	UJ	[illegible]	B	1.8	UN	1.6	UN
Vanadium	mg/Kg	28.4	100.0%	150	0	27	27	27.5	J	19.1		21.2	J	17.1		27.7		10.9	B
Zinc	mg/Kg	534	100.0%	115	7	27	27	[illegible]	J	68		[illegible]	J	52.3	*	81	E	37.2	E
Others																			
Total Solids	%W/W	85.8	100.0%		0	5	5												

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RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

Matrix								SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
Area								SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
Sample Depth (ft)								0.3		0 6		0 7		0.5		0.45		0 3	
Sample Date								11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
Location								63103		63104		63105		63106		63107		63108	
Sample Number																			
SDG																			
Parameter	Unit	Maximum Concentration Measured	Frequency of Detection	TAGM Level	Number of Samples above TAGM	Number of Samples where Detected	Number of Samples Collected	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds																			
Acetone	ug/Kg	150	29.6%	200	0	8	27	10	J	20	U	7	U	8	U	27	U	35	
2-Butanone	ug/Kg	35	7.4%	300	0	2	27	18	U	20	U	18	U	21	U	27	U	17	U
Benzene	ug/Kg	2	20.0%	60	0	1	5												
Toluene	ug/Kg	14	7.4%	1500	0	2	27	18	U	20	U	18	U	21	U	27	U	17	U
Xylene (total)	ug/Kg	14	20.0%	1200	0	1	5												
SemiVolatile Organic Compounds																			
2-Methylnaphthalene	ug/Kg	14	9.1%	36400	0	2	22	150	U	150	U	130	U	100	U	220	U	12	J
Benzo(a)anthracene	ug/Kg	2000	77.8%	224	3	21	27	15	J	12	J	9.5	J	8.1	J	130	J	[illegible]	
Benzo(a)pyrene	ug/Kg	2700	81.5%	61	12	22	27	22	J	15	J	12	J	10	J	[illegible]	J	[illegible]	
Benzo(b)fluoranthene	ug/Kg	3500	81.5%	1100	2	22	27	23	J	33	JY	14	J	15	J	240		1400	E
Benzo(k)fluoranthene	ug/Kg	1900	63.0%	1100	1	17	27	17	J	150	U	14	J	9.9	J	150	J	570	
bis(2-Ethylhexyl)phthalate	ug/Kg	1800	63.0%	50000	0	17	27	13	J	9.6	J	19	J	8.3	J	22	J	16	J
Butylbenzylphthalate	ug/Kg	120	27.3%	50000	0	6	22	150	U	150	U	130	U	100	U	16	J	120	U
Carbazole	ug/Kg	430	45.5%		0	10	22	150	U	150	U	130	U	100	U	32	J	260	
Chrysene	ug/Kg	2200	81.5%	400	3	22	27	22	J	15	J	14	J	12	J	180	J	[illegible]	
Di-n-butylphthalate	ug/Kg .	120	25.9%	8100	0	7	27	9 5	J	150	U	130	U	6.5	J	11	J	120	U
Di-n-octylphthalate	ug/Kg	19	4.5%	50000	0	1	22	150	U	150	U	130	U	100	U	220	U	120	U
Dibenz(a,h)anthracene	ug/Kg	1200	40.7%	14	9	11	27	150	U	150	U	130	U	100	U	[illegible]	J	[illegible]	
Dibenzofuran	ug/Kg	36	9.1%	6200	0	2	22	150	U	150	U	130	U	100	U	220	U	36	J
Diethyl phthalate	ug/Kg	92	40.9%	7100	0	9	22	150	U	150	U	7.5	J	100	U	220	U	120	U
Fluoranthene	ug/Kg	4300	81.5%	50000	0	22	27	31	J	28	J	23	J	18	J	360		1900	E
Fluorene	ug/Kg	110	13.6%	50000	0	3	22	150	U	150	U	130	U	100	U	220	U	79	J
Indeno(1,2,3-cd)pyrene	ug/Kg	2500	77.8%	3200	0	21	27	14	J	11	J	9.2	J	8.2	J	140	J	800	
Naphthalene	ug/Kg	23	9.1%	13000	0	2	22	150	U	150	U	130	U	100	U	220	U	21	J
Phenanthrene	ug/Kg	1500	81.5%	50000	0	22	27	12	J	12	J	11	J	6	J	120	J	940	
Phenol	ug/Kg	93	4.5%	30	1	1	22	150	U	150	U	130	U	100	U	220	U	120	U
Pyrene	ug/Kg	3200	95.5%	50000	0	21	22	24	J	19	J	18	J	14	J	240		1200	E
Organochlorine Pesticides																			
4,4'-DDE	ug/Kg	3.9	3.7%	2100	0	1	27	7.3	U	7.3	U	6.3	U	5	U	11	U	5.9	U
4,4'-DDD	ug/Kg	9.2	11.1%	2900	0	3	27	7.3	U	7.3	U	6.3	U	5	U	11	U	5.9	U
4,4'-DDT	ug/Kg	8.3	7.4%	2100	0	2	27	7.3	U	7.3	U	6.3	U	5	U	11	U	5.9	U
Endosulfan I	ug/Kg	7.5	9.1%	900	0	2	22	3.8	U	3.8	U	3.3	U	2.6	U	5.7	U	3	U
Endosulfan sulfate	ug/Kg	5.2	4.5%	1000	0	1	22	7.3	U	7.3	U	6.3	U	5	U	11	U	5.9	U
Endrin ketone	ug/Kg	9.4	4.5%		0	1	22	7.3	U	7.3	U	6.3	U	5	U	11	U	5.9	U

TABLE F-1

RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

						Matrix		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
						Area		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
						Sample Depth (ft)		0.3		0.6		0.7		0.5		0.45		0.3	
						Sample Date		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97		11-Dec-97	
						Location		63103		63104		63105		63106		63107		63108	
						Sample Number													
						SDG													
Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	**Value**	**(Q)**	**Value**	**(Q)**	**Value**	**(Q)**	**Value**	**(Q)**	**Value**	**(Q)**	**Value**	**(Q)**
Volatile Organic Compounds																			
Metals/Cyanide																			
Aluminum	mg/Kg	18000	100.0%	20650	0	27	27	11600	*	11900	*	13000	*	12800	*	12300	*	10900	*
Antimony	mg/Kg	0.23	20.0%	6.27	0	1	5												
Arsenic	mg/Kg	8.8	100.0%	9.6	0	27	27	4 7		4.1	B	4.6		5.2		6.8		4.1	
Barium	mg/Kg	107	100.0%	300	0	27	27	85.1	B	76.2	B	90.5		64		105	B	59.8	B
Beryllium	mg/Kg	0.8	100.0%	1.13	0	27	27	0.64	B	0 63	B	0.65	B	0.59	B	0.47	B	0 48	B
Cadmium	mg/Kg	0.83	33.3%	2.46	0	9	27	0.13	U	0.13	U	0.08	U	0.06	U	0.19	U	0.1	U
Calcium	mg/Kg	211000	100.0%	125300	2	27	27	7050	*	2650	*	3370	*	14400	*	55600	*	34800	*
Chromium	mg/Kg	24.8	100.0%	30.95	0	27	27	18 4	*	18.5	*	18.6	*	21.8	*	22.4	*	17.5	*
Cobalt	mg/Kg	14.4	100.0%	30	0	27	27	10.7	B	7.6	B	8.5	B	12.7	B	14.4	B	9.3	B
Copper	mg/Kg	42.6	100.0%	32.94	5	27	27	24.7		20.4		21.9		32		[illegible]		28.8	
Cyanide	mg/Kg	2.1	4.5%	0.35	1	1	22	1.1	UN	1.2	UN	0.96	UN	0.76	UN	1.7	UN	0.92	UN
Iron	mg/Kg	30100	100.0%	38110	0	27	27	21800	*	18700	*	20100	*	26000	*	24700	*	17800	*
Lead	mg/Kg	46.2	85.2%	23.49	9	23	27	26.5	N*	23.2	N*	24.6	N*	20.8	N*	[illegible]	N*	[illegible]	N*
Magnesium	mg/Kg	16100	100.0%	21890	0	27	27	5010	*	3260	*	3330	*	5400	*	14800	*	6280	*
Manganese	mg/Kg	995	100.0%	1095	0	27	27	284	*	222	*	344	*	346	*	760	*	344	*
Mercury	mg/Kg	0.13	44.0%	0.1	2	11	25	0.11	UN	0.11	UN	0.13	BN	0.06	UN	0.16	UN	0.07	UN
Nickel	mg/Kg	44.2	103.8%	52.58	0	27	26	29.4	*	22.7	*	25	*	42	*	39.6	*	30.1	*
Potassium	mg/Kg	2570	100.0%	2623	0	27	27	1530	B	1580	B	1580		1460		2350	B	2290	
Selenium	mg/Kg	2.1	40.7%	2	1	11	27	2	U	2	U	1.3	U	1.3	U	3	U	1.5	U
Sodium	mg/Kg	578	81.5%	187.8	15	22	27	[illegible]	B	[illegible]	B	[illegible]	B	[illegible]	B	[illegible]	B	[illegible]	B
Thallium	mg/Kg	2.3	14.8%	0.28	4	4	27	2.7	UN	2.7	UN	1.7	UN	1.7	UN	4	UN	2	UN
Vanadium	mg/Kg	28.4	100.0%	150	0	27	27	20.4	B	20.7	B	21.3		19.6		26.9	B	21.2	
Zinc	mg/Kg	534	100.0%	115	7	27	27	79.2	E	85.8	E	69.4	E	73.4	E	[illegible]	E	90.6	E
Others																			
Total Solids	%W/W	85.8	100.0%		0	5	5												

RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

Matrix								SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT		SEDIMENT	
Area								SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63		SEAD-63	
Sample Depth (ft)								0.5		0.4		0.4		0.4		0.4		0 3	
Sample Date								11-Dec-97		11-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97		12-Dec-97	
Location								63109		63110		63111		12217		63112		63113	
Sample Number																			
SDG																			
Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds																			
Acetone	ug/Kg	150	29.6%	200	0	8	27	9	J	17		21	U	24	UJ	68	J	16	U
2-Butanone	ug/Kg	35	7.4%	300	0	2	27	18	U	16	U	18	U	17	U	14	U	16	U
Benzene	ug/Kg	2	20.0%	60	0	1	5												
Toluene	ug/Kg	14	7.4%	1500	0	2	27	18	U	16	U	16	U	17	UJ	14	U	16	U
Xylene (total)	ug/Kg	14	20 0%	1200	0	1	5												
SemiVolatile Organic Compounds																			
2-Methylnaphthalene	ug/Kg	14	9.1%	36400	0	2	22	14	J	100	U	120	U	120	U	160	U	120	U
Benzo(a)anthracene	ug/Kg	2000	77.8%	224	3	21	27	[illegible]	E	160		110	J	120	J	25	J	75	J
Benzo(a)pyrene	ug/Kg	2700	81.5%	61	12	22	27	[illegible]	E	200		130	J	[illegible]		56	J	[illegible]	J
Benzo(b)fluoranthene	ug/Kg	3500	81.5%	1100	2	22	27	[illegible]	E	240		160	YJ	170		72	J	130	
Benzo(k)fluoranthene	ug/Kg	1900	63.0%	1100	1	17	27	[illegible]	E	200		120	U	120		160	U	63	J
bis(2-Ethylhexyl)phthalate	ug/Kg	1800	63.0%	50000	0	17	27	20	J	12	J	120	JB	120	U	160	U	120	U
Butylbenzylphthalate	ug/Kg	120	27.3%	50000	0	6	22	150	U	100	U	120	J	15	U	160	U	120	U
Carbazole	ug/Kg	430	45.5%		0	10	22	430		28	J	19	U	24	J	160	U	17	J
Chrysene	ug/Kg	2200	81.5%	400	3	22	27	2200	E	220		150	J	150		49	J	100	J
Di-n-butylphthalate	ug/Kg.	120	25.9%	8100	0	7	27	150	U	100	U	120	JB	120	U	160	U	120	U
Di-n-octylphthalate	ug/Kg	19	4.5%	50000	0	1	22	150	U	100	U	120	U	120	U	160	U	120	U
Dibenz(a,h)anthracene	ug/Kg	1200	40.7%	14	9	11	27	1200		[illegible]	J	28	J	[illegible]	J	160	U	12	J
Dibenzofuran	ug/Kg	36	9.1%	6200	0	2	22	35	J	100	U	120	U	120	U	160	U	120	U
Diethyl phthalate	ug/Kg	92	40.9%	7100	0	9	22	150	U	100	U	8.2	JB	6.2	J	92	J	6.4	J
Fluoranthene	ug/Kg	4300	81.5%	50000	0	22	27	4300	E	400		250	J	250		43	J	180	
Fluorene	ug/Kg	110	13.6%	50000	0	3	22	110	J	10	J	120	U	120	U	160	U	120	U
Indeno(1,2,3-cd)pyrene	ug/Kg	2500	77.8%	3200	0	21	27	2500	E	170		97	J	93	J	27	J	65	J
Naphthalene	ug/Kg	23	9.1%	13000	0	2	22	23	J	100	U	120	U	120	U	160	U	120	U
Phenanthrene	ug/Kg	1500	81.5%	50000	0	22	27	1500	E	120		80	J	88	J	37	J	58	J
Phenol	ug/Kg	93	4.5%	30	1	1	22	150	U	100	U	120	U	11	U	160	U	120	U
Pyrene	ug/Kg	3200	95.5%	50000	0	21	22	3200	E	290		180	J	200		45	J	120	J
Organochlorine Pesticides																			
4,4'-DDE	ug/Kg	3.9	3.7%	2100	0	1	27	7.7	U	5.2	U	6	U	5.9	U	2.1	U	6.2	U
4,4'-DDD	ug/Kg	9.2	11.1%	2900	0	3	27	7.7	U	5.2	U	6	U	5.9	U	3.1	J	6.2	U
4,4'-DDT	ug/Kg	8.3	7.4%	2100	0	2	27	12	U	5.2	U	6	U	5.9	U	8.3		6.2	U
Endosulfan I	ug/Kg	7.5	9.1%	900	0	2	22	4	U	2.6	U	3.1	U	3	U	2.1	U	3.2	U
Endosulfan sulfate	ug/Kg	5.2	4.5%	1000	0	1	22	12	U	6.1	U	6	U	5.9	U	4.1	U	6.2	U
Endrin ketone	ug/Kg	9.4	4.5%		0	1	22	12	U	3.9	U	6	U	5.9	U	4.1	U	6.2	U

TABLE F-1

RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

Matrix	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
Area	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63	SEAD-63
Sample Depth (ft)	0.5	0.4	0.4	0.4	0.4	0.3
Sample Date	11-Dec-97	11-Dec-97	12-Dec-97	12-Dec-97	12-Dec-97	12-Dec-97
Location	63109	63110	63111	12217	63112	63113
Sample Number						
SDG						

Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds																			
Metals/Cyanide																			
Aluminum	mg/Kg	18000	100.0%	20650	0	27	27	11000	*	6320	*	7030	*	9230	*	2600	*	12900	*
Antimony	mg/Kg	0.23	20.0%	6.27	0	1	5												
Arsenic	mg/Kg	6.8	100 0%	9.6	0	27	27	5 7		3.8		3.1		3.2		2.5		5	
Barium	mg/Kg	107	100 0%	300	0	27	27	81.3	B	34.7	B	48 8		63.9	B	26.8	B	70.9	
Beryllium	mg/Kg	0.8	100 0%	1.13	0	27	27	0 28	B	0.29	B	0 25	B	0.3	B	0.08	B	0 49	B
Cadmium	mg/Kg	0.83	33.3%	2.46	0	9	27	0.13	U	0.09	U	0.08	U	0.1	U	0.06	U	0.09	U
Calcium	mg/Kg	211000	100.0%	125300	2	27	27	43300	*	90000	*	47400	*	69000		211000		27300	
Chromium	mg/Kg	24.8	100 0%	30.95	0	27	27	18.8	*	12	*	12 4	*	17.3	*	7.9	*	23 1	*
Cobalt	mg/Kg	14.4	100.0%	30	0	27	27	12	B	7.5	B	8.2	B	11.2	B	2.7	B	12.8	B
Copper	mg/Kg	42.6	100.0%	32.94	5	27	27	31.2		20.2		22.1		30.5		7.4		[illegible]	
Cyanide	mg/Kg	2.1	4.5%	0.35	1	1	22	1.2	UN	0.78	UN	0.99	UN	0.89	UJ	0.63	UJ	1	UJ
Iron	mg/Kg	30100	100.0%	38110	0	27	27	20900	*	12800	*	12700	*	19800		6360		24600	
Lead	mg/Kg	46.2	85.2%	23.49	9	23	27	46.2	N*	19.8	N*	24.9	N*	[illegible]	*	3.4	*	[illegible]	*
Magnesium	mg/Kg	16100	100.0%	21890	0	27	27	9980	*	9640	*	7590	*	12300	*	16100	*	9460	*
Manganese	mg/Kg.	995	100.0%	1095	0	27	27	995	*	315	*	475	*	748	J	315	J	559	J
Mercury	mg/Kg	0.13	44 0%	0.1	2	11	25	0.1	UN	0.06	UN	0.09	UN	0.07	U	0.05	U	0.09	U
Nickel	mg/Kg	44.2	103.8%	52.58	0	27	26	33.7	*	21.1	*	20.8	*	29		4.5	B	32.1	
Potassium	mg/Kg	2570	100.0%	2623	0	27	27	2000	B	1360	B	1160		1180	B	509	B	1980	
Selenium	mg/Kg	2.1	40.7%	2	1	11	27	2.1	U	1.4	U	1.3	U	1.7	B	0.94	U	[illegible]	
Sodium	mg/Kg	578	81.5%	187.8	15	22	27	443	B	[illegible]	B	343	B	[illegible]	B	122	U	[illegible]	B
Thallium	mg/Kg	2.3	14.8%	0.28	4	4	27	2.8	UN	1.8	UN	1.7	UN	2.1	U	1.3	U	[illegible]	B
Vanadium	mg/Kg	28.4	100.0%	150	0	27	27	28		15.5		15.8		20.9		11.7		24.3	
Zinc	mg/Kg	534	100.0%	115	7	27	27	534	E	[illegible]	E	87.4	E	[illegible]	*	24.7	*	[illegible]	*
Others																			
Total Solids	%W/W	85.8	100.0%		0	5	5												

.E F-1

RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

Parameter	Unit	Maximum Concentration Measured	Frequency of Detection	TAGM Level	Number of Samples above TAGM	Number of Samples where Detected	Number of Samples Collected	Value	(Q)	Value	(Q)	Value	(Q)
						Matrix		SEDIMENT		SEDIMENT		SEDIMENT	
						Area		SEAD-63		SEAD-63		SEAD-63	
						Sample Depth (ft)		0.3		0.3		0.3	
						Sample Date		12-Dec-97		12-Dec-97		13-Dec-97	
						Location		63114		63115		63116	
						Sample Number							
						SDG							
Volatile Organic Compounds													
Acetone	ug/Kg	150	29.6%	200	0	8	27	15	U	15	U	25	J
2-Butanone	ug/Kg	35	7.4%	300	0	2	27	15	U	15	U	14	U
Benzene	ug/Kg	2	20.0%	60	0	1	5						
Toluene	ug/Kg	14	7.4%	1500	0	2	27	15	U	15	U	14	UJ
Xylene (total)	ug/Kg	14	20.0%	1200	0	1	5						
SemiVolatile Organic Compounds													
2-Methylnaphthalene	ug/Kg	14	9.1%	36400	0	2	22	94	U	120	U	93	U
Benzo(a)anthracene	ug/Kg	2000	77.8%	224	3	21	27	9.2	J	33	J	93	
Benzo(a)pyrene	ug/Kg	2700	81.5%	61	12	22	27	12	J	30	J	93	
Benzo(b)fluoranthene	ug/Kg	3500	81.5%	1100	2	22	27	18	J	51	J	93	
Benzo(k)fluoranthene	ug/Kg	1900	63.0%	1100	1	17	27	8.7	J	33	J	93	
bis(2-Ethylhexyl)phthalate	ug/Kg	1800	63.0%	50000	0	17	27	94	U	120	U	93	U
Butylbenzylphthalate	ug/Kg	120	27.3%	50000	0	6	22	94	U	6.7	J	5.7	J
Carbazole	ug/Kg	430	45.5%		0	10	22	94	U	15	J	93	J
Chrysene	ug/Kg	2200	81.5%	400	3	22	27	13	J	43	J	93	
Di-n-butylphthalate	ug/Kg.	120	25.9%	8100	0	7	27	94	U	120	U	93	U
Di-n-octylphthalate	ug/Kg	19	4.5%	50000	0	1	22	94	U	120	U	93	U
Dibenz(a,h)anthracene	ug/Kg	1200	40.7%	14	9	11	27	94	U	8.8	J	93	J
Dibenzofuran	ug/Kg	38	9.1%	6200	0	2	22	94	U	120	U	93	U
Diethyl phthalate	ug/Kg	92	40.9%	7100	0	9	22	94	U	9.5	J	7.6	J
Fluoranthene	ug/Kg	4300	81.5%	50000	0	22	27	25	J	82	J	93	
Fluorene	ug/Kg	110	13.6%	50000	0	3	22	94	U	120	U	93	U
Indeno(1,2,3-cd)pyrene	ug/Kg	2500	77.8%	3200	0	21	27	9.5	J	28	J	93	J
Naphthalene	ug/Kg	23	9.1%	13000	0	2	22	94	U	120	U	93	U
Phenanthrene	ug/Kg	1500	81.5%	50000	0	22	27	11	J	35	J	6.4	J
Phenol	ug/Kg	93	4.5%	30	1	1	22	94	U	120	U	93	J
Pyrene	ug/Kg	3200	95.5%	50000	0	21	22	17	J	58	J	93	
Organochlorine Pesticides													
4,4'-DDE	ug/Kg	3.9	3.7%	2100	0	1	27	4.7	U	5.9	U	4.6	U
4,4'-DDD	ug/Kg	9.2	11.1%	2900	0	3	27	4.7	U	5.9	U	4.6	U
4,4'-DDT	ug/Kg	8.3	7.4%	2100	0	2	27	4.7	U	5.9	U	4.6	U
Endosulfan I	ug/Kg	7.5	9.1%	900	0	2	22	2.4	U	3	U	2.4	U
Endosulfan sulfate	ug/Kg	5.2	4.5%	1000	0	1	22	4.7	U	5.9	U	4.6	U
Endrin ketone	ug/Kg	9.4	4.5%		0	1	22	4.7	U	5.9	U	4.6	U

TABLE F-1

RI SHALLOW SOIL/SEDIMENT ANALYSIS RESULTS
SEAD-63 ENGINEERING EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, NY

Matrix	SEDIMENT	SEDIMENT	SEDIMENT
Area	SEAD-63	SEAD-63	SEAD-63
Sample Depth (ft)	0.3	0.3	0.3
Sample Date	12-Dec-97	12-Dec-97	13-Dec-97
Location	63114	63115	63116
Sample Number			
SDG			

Parameter	**Unit**	**Maximum Concentration Measured**	**Frequency of Detection**	**TAGM Level**	**Number of Samples above TAGM**	**Number of Samples where Detected**	**Number of Samples Collected**	Value	(Q)	Value	(Q)	Value	(Q)
Volatile Organic Compounds													
Metals/Cyanide													
Aluminum	mg/Kg	18000	100.0%	20650	0	27	27	9090	*	12700	*	15200	*
Antimony	mg/Kg	0.23	20.0%	6.27	0	1	5						
Arsenic	mg/Kg	6.8	100.0%	9.6	0	27	27	3.3		3		5 6	B
Barium	mg/Kg	107	100 0%	300	0	27	27	62.7		57.7		94.4	B
Beryllium	mg/Kg	0.8	100.0%	1.13	0	27	27	0.43	B	0.48	B	0.6	B
Cadmium	mg/Kg	0.83	33.3%	2.48	0	9	27	0.08	U	0.09	U	0.06	U
Calcium	mg/Kg	211000	100 0%	125300	2	27	27	103000		3750		19600	
Chromium	mg/Kg	24.8	100.0%	30.95	0	27	27	15.2	*	19.2	*	24 4	*
Cobalt	mg/Kg	14.4	100.0%	30	0	27	27	6.9	B	7	B	13.3	B
Copper	mg/Kg	42.6	100.0%	32.94	5	27	27	18.7		18.2		30.8	
Cyanide	mg/Kg	2.1	4.5%	0.35	1	1	22	0.72	UJ	1	UJ	0 8	UJ
Iron	mg/Kg	30100	100.0%	38110	0	27	27	17200		20000		29700	
Lead	mg/Kg	46.2	85.2%	23.49	9	23	27	17.2	*	18	*	15.7	*
Magnesium	mg/Kg	16100	100.0%	21890	0	27	27	5850	*	3820	*	7140	*
Manganese	mg/Kg,	995	100.0%	1095	0	27	27	255	J	217	J	520	J
Mercury	mg/Kg	0.13	44.0%	0.1	2	11	25	0.07	U	0.07	U	0.06	U
Nickel	mg/Kg	44.2	103.8%	52.58	0	27	28	20.3		18.9		38.6	
Potassium	mg/Kg	2570	100.0%	2823	0	27	27	1280	B	1380	B	1840	B
Selenium	mg/Kg	2.1	40.7%	2	1	11	27	1.2	U	1.4	B	1	B
Sodium	mg/Kg	578	81.5%	187.8	15	22	27	170	B	172	U	130	U
Thallium	mg/Kg	2.3	14.8%	0.28	4	4	27	1.6	U	1.8	U	1.7	U
Vanadium	mg/Kg	28.4	100.0%	150	0	27	27	17.3		20.9		24	
Zinc	mg/Kg	534	100.0%	115	7	27	27	66.6	*	60.4	*	72.1	*
Others													
Total Solids	%W/W	85.8	100.0%		0	5	5						

TABLE F-2
INORGANICS ANALYSIS OF SOIL - SEAD-63
Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity

	Average of Background Soils (mg/kg)	2 x Average of Background Soils (mg/kg)	Average of SEAD-63 Soils (mg/kg)	Is Average of Site data > than 2 x Average of Background data?
Aluminum	13340.53	26681.05	14641.67	No
Antimony	3.56	7.12	0.26	No
Arsenic	5.08	10.15	4.68	No
Barium	78.43	156.86	73.09	No
Beryllium	0.67	1.33	0.66	No
Cadmium	0.97	1.94	2.96	Yes
Calcium	45449.65	90899.30	19976.67	No
Chromium	20.32	40.64	25.31	No
Cobalt	11.39	22.79	12.43	No
Copper	20.99	41.97	33.15	No
Iron	24704.74	49409.47	28291.67	No
Lead	16.47	32.95	22.24	No
Magnesium	10290.18	20580.35	6735.83	No
Manganese	576.14	1152.28	441.00	No
Mercury	0.04	0.09	0.09	Yes
Nickel	30.39	60.79	38.08	No
Potassium	1487.25	2974.49	1640.83	No
Selenium	0.63	1.26	1.17	No
Sodium	99.42	198.85	94.67	No
Thallium	0.43	0.86	0.38	No
Vanadium	21.41	42.82	22.71	No
Zinc	67.80	135.60	83.28	No

Notes:
A "Yes" value indicates that site metal levels are higher than background levels and metal will be retained for risk assessment.
A "No" value indicates that levels are considered to be similar to background levels and metal will not be retained for risk assessment.

TABLE F-3
INORGANICS ANALYSIS OF GROUNDWATER - SEAD-63
Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity

	Average of Background Groundwater (ug/L)	2 x Average of Background Groundwater (ug/L)	Average of SEAD-63 Groundwater (ug/L)	Is Average of Site data > than 2 x Average of Background data?
Aluminum	2923.01	5846.01	622.00	No
Barium	81.20	162.40	75.60	No
Calcium	115619.35	231238.71	172133.33	No
Chromium	8.67	17.35	1.04	No
Cobalt	6.84	13.68	4.93	No
Copper	5.39	10.79	2.03	No
Iron	4476.26	8952.53	961.00	No
Lead	6.59	13.18	1.10	No
Magnesium	28567.74	57135.48	30333.33	No
Manganese	231.41	462.82	675.33	Yes
Nickel	10.57	21.14	8.20	No
Potassium	4065.59	8131.17	3856.67	No
Sodium	15020.67	30041.33	52523.33	Yes
Vanadium	8.23	16.47	1.27	No
Zinc	25.37	50.74	8.30	No

Notes:
A "Yes" value indicates that site metal levels are higher than background levels and metal will be retained for risk assessment.
A "No" value indicates that levels are considered to be similar to background levels and metal will not be retained for risk assessment.

TABLE F-4
INORGANICS ANALYSIS OF SOIL/SEDIMENT - SEAD-63
Ecological Mini-risk Assessment Dataset
Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity

	Average of Background Soils (mg/kg)	2 x Average of Background Soils (mg/kg)	Average of SEAD-63 Soils (mg/kg)	Is Average of Site data > than 2 x Average of Background data?
Aluminum	13340.53	26681.05	11887.06	No
Antimony	3.56	7.12	0.26	No
Arsenic	5.08	10.15	4.29	No
Barium	78.43	156.86	68.28	No
Beryllium	0.67	1.33	0.53	No
Cadmium	0.97	1.94	2.37	Yes
Calcium	45449.65	90899.30	40367.94	No
Chromium	20.32	40.64	20.16	No
Cobalt	11.39	22.79	10.59	No
Copper	20.99	41.97	28.04	No
Iron	24704.74	49409.47	22336.76	No
Lead	16.47	32.95	23.44	No
Magnesium	10290.18	20580.35	7663.82	No
Manganese	576.14	1152.28	451.29	No
Mercury	0.04	0.09	0.08	No
Nickel	30.39	60.79	31.27	No
Potassium	1487.25	2974.49	1578.41	No
Selenium	0.63	1.26	1.24	No
Sodium	99.42	198.85	215.67	Yes
Thallium	0.43	0.86	0.83	No
Vanadium	21.41	42.82	21.31	No
Zinc	67.80	135.60	117.34	No

Notes:
A "Yes" value indicates that site metal levels are higher than background levels and metal will be retained for risk assessment.
A "No" value indicates that levels are considered to be similar to background levels and metal will not be retained for risk assessment.

TABLE F-5
EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN - SEAD-63
Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity

COMPOUNDS	Total Soil (1) mg/Kg	Surface Soil (1) mg/Kg	Groundwater (1) mg/L	Surface Water (1) mg/L	Sediment (1) mg/Kg	Surface Soil and Sediment (2) mg/Kg
Volatile Organics						
Acetone	0.16				0.15 J	0.15 J
2-Butanone	0.046					
Benzene	0.004 J	0.002 J				0.002 J
Chloroform				0.0008 J		
Methyl ethyl ketone					0.035 J	0.035 J
Toluene	0.023	0.006 J		0.001	0.014 J	0.014 J
Xylene (total)	0.014	0.014				0.014
Semivolatile Organics						
2-Methylnaphthalene					0.014 J	0.014 J
4-Methylphenol				0.00022 J		
Benzo(a)anthracene	0.03 J				2 E	2 E
Benzo(a)pyrene	0.045 J	0.024 J		0.001 J	2.7 E	2.7 E
Benzo(b)fluoranthene	0.038 J	0.021 J		0.0009 J	3.5 E	3.5 E
Benzo(g,h,i)perylene	0.031 J			0.0008 J		
Benzo(k)fluoranthene	0.043 J	0.021 J		0.001 J	1.9 E	1.9 E
bis(2-Ethylhexyl)phthalate	1.8 J	1.8 J		0.068	0.11 B	1.8 J
Butylbenzylphthalate				0.00023 JB	0.12 J	0.12 J
Carbazole					0.43	0.43
Chrysene	0.031 J	0.023 J			2.2 E	2.2 E
Dibenz(a,h)anthracene	0.028 J			0.0008 J	1.2	1.2
Di-n-butylphthalate	0.087 J			0.00015 JB	0.120 JB	0.120 JB
Di-n-octylphthalate					0.019 J	0.019 J
Dibenzofuran					0.036 J	0.036 J
Diethyl phthalate				0.00029 J	0.092 J	0.092 J
Fluoranthene	0.063 J	0.038 J		0.0007 J	4.3 E	4.3 E
Fluorene					0.11 J	0.11 J
Indeno(1,2,3-cd)pyrene	0.037 J			0.0009 J	2.5 E	2.5 E
Naphthalene					0.023 J	0.023 J
Pentachlorophenol				0.001 J		
Phenanthrene	0.031 J			0.000057 J	1.5 E	1.5 E
Phenol	-		0.002 J	0.0008 J	93	93
Pyrene				0.0005 J	3.2 E	3.2 E
Pesticides/PCBs						
4,4'-DDD	0.002 J				0.0039 J	0.0039 J
4,4'-DDE	0.0044 J				0.0092 J	0.0092 J
4,4'-DDT	0.0033 J				0.0083	0.0083
Endosulfan I					0.0075 J	0.0075 J
Endosulfan sulfate				0.000014 P	0.0052 J	0.0052 J
Endrin ketone				0.000046	0.0094 J	0.0094 J
Metals						
Aluminum				3.63		
Antimony						
Arsenic				0.0038 J		
Barium				0.0914 J		
Beryllium				0.00019 B		
Cadmium	24	0.56 J		0.00078 J	0.83 J	0.83 J
Calcium				220		
Chromium				0.0056 J		
Cobalt				0.0072 J		
Copper				0.0079 J		
Cyanide						
Iron				9.05		
Lead				0.02		
Magnesium				33.7		
Manganese			1.07	2.3		
Mercury	0.49	0.06 J		0.0001 J		
Nickel				0.0188 J		
Potassium				11.6		
Selenium						
Silver				0.00089 J		
Sodium			146	59.3	578 B	578 B
Thallium				0.0019 J		
Vanadium				0.0089 J		
Zinc				0.099		

climate, vegetation, soil characteristics, and surface and groundwater hydrology. All potentially exposed populations and sub-populations therein (receptors) are assessed relative to their potential for exposure. Additionally, locations relative to the site along with the current and potential future land use of the site are considered. This step is a qualitative one aimed at providing a general site perspective and offering insight on the surrounding population.

2) **Identify Exposure Pathways:** All exposure pathways, ways in which receptors can be exposed to contaminants that originate from the source, are reviewed in this step. Chemical sources and mechanisms for release along with subsequent fate and transport are investigated. Exposure points of human contact and exposure routes are discussed before quantifying the exposure pathways in step 3.

3) **Quantify Exposure:** In this final step, the exposure levels (COPC intakes or doses) are calculated for each exposure pathway and receptor. These calculations typically follow EPA guidance for assumptions of intake variables or exposure factors for each exposure pathway and EPA-recommended calculation methods.

Figure F-1 illustrates the exposure assessment process.

F.3.2 Physical Setting and Characteristics

The physical setting and characteristics of the site are described in **Sections 2.1, 2.5, and 2.6** of **Section 2 of Appendix A.**

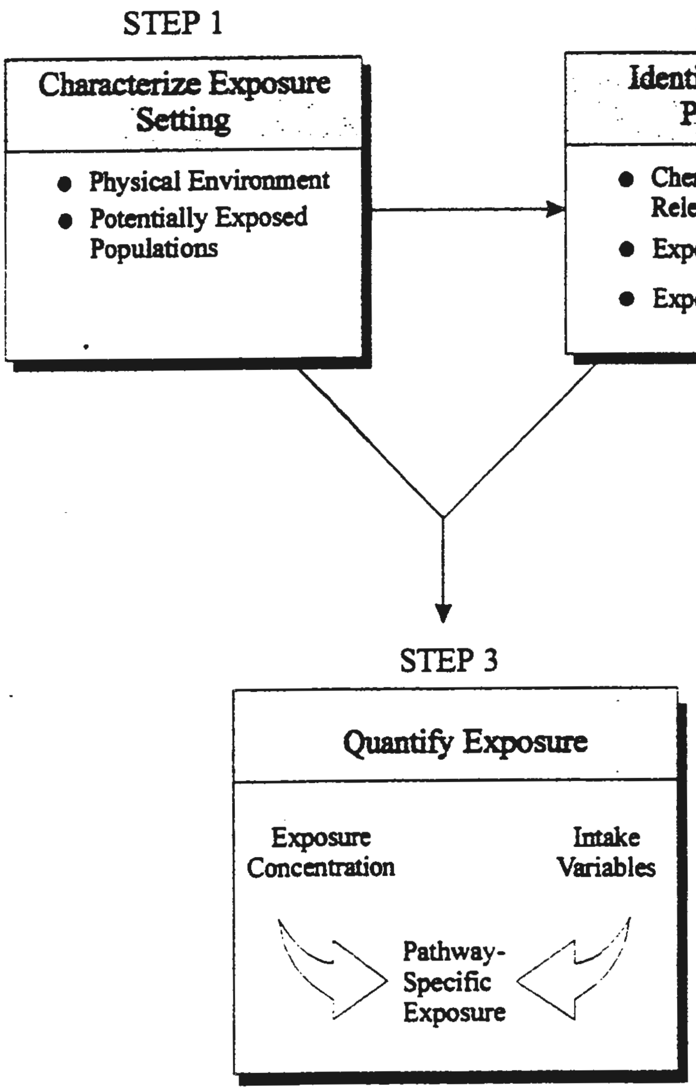
F.3.3 Land Use and Potentially Exposed Populations

F.3.3.1 Current Land Use

There is no current land use for SEAD-63. The site is abandoned and is no longer in use. This site is in the northwestern portion of SEDA. There are no drinking water supply wells at SEAD-63 and perimeter chain link fencing permits access to the site. The site has no actual site workers but is occasionally patrolled by site security personnel.

F.3.3.2 Potential Future Land Use

EPA guidance for determining future land uses recommends that, if available, master plans, which include future land uses, Bureau of Census projections and established land use trends in the general area should be utilized to establish future land use trends.



Source: USEPA, 1989a

PARSONS
PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE
SENECA ARMY DEPOT ACTIVITY

DEPT ENVIRONMENTAL ENGINEERING
DWG NO

FIGURE F-1

EXPOSURE ASSESSMENT PROCESS

SCALE Not Applicable
DATE April 2001

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In July 1995, the Base Realignment and Closure Act (BRAC) Commission voted to recommend closure of SEDA. Congress approved the recommendation, which became public law on October 1, 1995. According to BRAC regulations, the Army will determine future uses of the site.

In accordance with BRAC regulations, the Army will notify all appropriate regulatory agencies and will perform any additional investigations and remedial actions to assure that any changes in the intended use of the sites is protective of human health and the environment in accordance with CERCLA. Also, Army regulations (Regulation 200-1, paragraph 12-5, Real Property Transactions), require that the Army perform an Environmental Baseline Study (EBS) prior to a transfer of Army property. The EBS is an inventory and a comprehensive evaluation of the existing environmental conditions and consists of scope definition, survey, sampling, investigative and risk assessment

SEDA has been placed on the 1995 Base Realignment and Closure List (BRAC List). The President and the Congress have approved the list and it has become public law. As BRAC applies to SEDA, the Army will determine future land use of the sites. At the time this Action Memorandum was prepared, the Local Redevelopment Authority (LRA) had been given sole discretion in determining the future uses of the SEDA facility. This Land Reuse Plan is the basis for future land use assumptions for SEAD-63 included in this risk assessment. The LRA has established that the Q Area, which includes SEAD-63, will be used as a Wildlife Conservation Area. At the time when the SEDA facility is relinquished by the Army, the Army will ensure that SEAD-63 can be used for the intended purpose.

F.3.3.3 Potentially Exposed Populations

Three potentially exposed populations that are relevant to the future land use are evaluated in this risk assessment. Since current exposure is infrequent and limited, only future receptors under the future land use scenarios are considered in this mini-risk assessment.

The three (3) exposed populations are:
1. Park worker,
2. construction worker, and
3. recreational visitor (child).

Residential receptors (including adult and child) were considered for comparative purposes only. Future residential use of the land is highly unlikely.

F.3.4 Identification of Exposure Pathways

Exposures are estimated only for plausible completed exposure pathways. A completed exposure pathway has the following four elements:

- a source and mechanism for chemical release,
- an environmental transport medium,
- an exposure point, and
- a human receptor and a feasible route of exposure at the exposure point.

A pathway cannot be completed unless each of these elements is present. **Figure 2-12** in **Section 2** of **Appendix A** illustrates the completed exposure pathways for SEAD-63. Although not shown in Figure 2-12, risks for a residential receptor via the plausible exposure pathways (i.e., same exposure pathways as for a recreational visitor) were evaluated. Future residential use of the land is highly unlikely.

F.3.4.1 Sources and Receiving Media

The suspected source at SEAD-63 is buried miscellaneous components and soil associated with the components at SEAD-63. The primary release mechanisms from the site are surface water runoff and infiltration of precipitation. Groundwater, surface water, and sediment are secondary sources.

F.3.4.2 Summary of Exposure Pathways to be Quantified

The pathways presented reflect the projected future onsite use of SEAD-63. This section presents the rationale for including these exposure pathways in this risk assessment.

Inhalation of Particulate Matter in Ambient Air

Surface soil particles may become airborne via wind erosion, which in turn may be inhaled by individuals at the site. Construction workers may also be exposed to subsurface soil particles. Therefore, inhalation exposure to soil particulates in ambient air was assessed for all future receptors.

Incidental Ingestion and Dermal Contact to On-Site Surface Soils

During the course of daily activities, a park worker or recreational visitor could come into contact with site surface soils and involuntarily ingest and/or have their skin exposed to them. Therefore, exposure via dermal contact and soil ingestion was assessed for these two receptors.

Incidental Ingestion and Dermal Contact to On-Site Surface and Subsurface Soils

The laboratory analyses of all surface and subsurface soils show the presence of VOCs, semi-volatile organics, pesticides, and metals. During the course of daily activities, an on-site construction worker will come into contact with these surface and subsurface soils during intrusive activities and may involuntarily ingest and have his/her skin exposed to them. Therefore, exposure via both dermal contact and soil ingestion was assessed for the future construction worker.

Ingestion of Groundwater

There is no current use of groundwater as a potable water source at the Depot. Potable water is supplied to the Depot from a water supply line that passes through the Town of Varick. Varick's water is obtained from the water treatment plant at the Town of Waterloo. The source of this water is Lake Seneca. It is unlikely that a groundwater well would be installed for future drinking water use. The shallow groundwater aquifer at the site is inadequate for both yield and quality. Nonetheless, since this use is not prevented via an institutional control such as a deed restriction, it was assumed that wells would be installed on-site for potable water. Therefore, this is considered a complete pathway for receptors at the site.

Inhalation and Dermal Contact with Groundwater while Showering

Recreational visitors may come into contact with groundwater while taking daily showers. These receptors may be exposed to all chemicals contained in groundwater during showering by dermal contact, and volatile chemicals which partition into the air via inhalation. Therefore, this is considered a complete pathway and data from the on-site wells are used to calculated exposure concentrations.

Dermal Contact with Surface Water and Sediment while Wading

The drainage ditches in the area of SEAD-63 are dry most of the time during the year except when they carry storm-water runoff (e.g., during spring seasons when snow melts). The drainage ditches are shallow (generally less than 3 ft below the ground surface of the road). Recreational visitors may come into contact with surface water during a wading event. Recreational visitors may also contact with ditch sediment and be exposed to all chemicals contained in sediment. Therefore, this is considered a complete pathway and surface water and sediment data from the site are used to calculated exposure concentrations.

F.3.4.3 Quantification of Exposure

In this section, each receptor's potential exposures to chemicals of potential concern (COPCs) are quantified for each of the exposure pathways described above. In each case, the exposures are calculated following methods recommended in EPA guidance documents, such as the Risk Assessment Guidance for Superfund (EPA 1989). These calculations generally involve two steps. First, representative chemical concentrations in the environment, or exposure point concentrations (EPCs), are determined for each pathway and receptor. From these EPC values, the amount of chemical that an exposed person may take into his/her body is then calculated. This value is referred to as either the Human Intake or the Absorbed Dose, depending on the exposure route.

This section describes the exposure scenarios, exposure assumptions and exposure calculation methods used in this risk assessment. All calculations are shown in the tables included in **Attachment** A to this Appendix.

Risk assessment as a whole, and the exposure assessment step in particular, are designed to be health protective. The exposure calculations require estimates and assumptions about certain human exposure parameters, such as inhalation rates, ingestion rates, etc. Generally, values are selected which tend to overestimate exposure. USEPA (1993) recommends two types of exposure estimates to be used for Superfund risk assessments: a reasonable maximum exposure (RME) and central tendency exposure (CT). The RME is defined as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site, and is intended to account for both uncertainty in the contaminant concentration and variability in the exposure parameters (such as exposure frequency or averaging time). The CT also may be evaluated for comparison purposes and is generally based on mean exposure parameters. Only RME scenarios have been evaluated in this mini-risk assessment.

Superfund risk assessments consider chronic exposures unless specific conditions warrant a short-term or an acute assessment. In this evaluation, long-term exposure to relatively low chemical concentrations is the greatest concern. Short-term (i.e., subchronic) and acute exposures were evaluated only for the construction worker.

Exposure-point concentrations (EPCs) were estimated for all pathways selected for quantitative evaluation. These concentrations are based on the highest measured values (for soil and groundwater) or on calculated estimates (for ambient air and showering). Steady-state conditions were assumed. Therefore, current and future chemical concentrations were assumed to be identical. This assumption may tend to overestimate long-term exposure concentrations because chemical concentrations are likely to decrease over time from natural processes such as dispersion, attenuation, degradation and dilution.

Estimates of pathway-specific human intakes or absorbed doses for each chemical involve assumptions about patterns of human exposure to contaminated media. These assumptions are integrated with exposure-point concentrations to calculate intakes. Intakes or doses are normally expressed as the amount of chemical at the environment-human receptor exchange boundary in milligrams per kilogram of body weight per day (mg/kg-day), which represents an exposure normalized for body weight over time. The total exposure is divided by the time period of interest to obtain an average exposure. The averaging time is a function of the toxic endpoint: for noncarcinogenic effects, it is the exposure time (specific to the scenario being assessed) and for carcinogenic effects, it is lifetime (70 years).

F3.5 Exposure Assessment

F.3.5.1 Exposure Assumptions

An important aspect of exposure assessment is the determination of assumptions regarding how receptors may be exposed to contaminants. USEPA guidance on exposure factors is extensive and was followed throughout this exposure assessment. Standard scenarios and EPA-recommended default assumptions were used where appropriate.

The exposure scenarios in this assessment involve the following future receptors: park worker, construction worker, and recreational visitor (child). The exposure assumptions for these scenarios are intended to approximate the frequency, duration and manner in which receptors are exposed to environmental media. For example, the worker scenarios are intended to approximate the exposure potential of those employed at the site.

Details of the exposure assumptions and parameters for each exposure scenario are presented in **Table F-6**.

TABLE F-6
EXPOSURE FACTOR ASSUMPTIONS FOR CONSERVATION/RECREATIONAL LAND
SEAD-63 EE/CA
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	PARAMETER	RME		BASIS	SOURCE
			VALUE	UNITS		
PARK WORKER	**Inhalation of Dust in Ambient Air** (Air EPC Calculated from Surface Soil Only)	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Inhalation Rate	8	m3/day	Average inhalation rate for light activity is 1.0 m3/hr, 8 hr work day.	USEPA, 1997.
		Exposure Frequency	175	days/yr	Works on-site 5 days/wk, 8 months/yr (35 weeks).	BPJ.
		Exposure Duration	25	years	Upper bound time for employment at a job.	USEPA, 1991, 1993.
		Averaging Time - Nc	9,125	days	25 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Ingestion of Soil (Soil EPC Calculated from Surface Soil Only)	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Ingestion Rate	100	mg soil/day	Upper bound worker exposure to dirt and dust.	USEPA, 1993.
		Fraction Ingested	1	(unitless)	100% ingestion, conservative assumption.	BPJ.
		Exposure Frequency	175	days/yr	Works on-site 5 days/wk, 8 months/yr (35 weeks).	BPJ.
		Exposure Duration	25	years	Upper bound time for employment at a job.	USEPA, 1991, 1993.
		Averaging Time - Nc	9,125	days	25 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Dermal Contact of Soil (Soil EPC Calculated from Surface Soil Only)	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Absorption Factor	Compound	Specific		USEPA, 1999.
		Skin Contact Surface Area	5,700	cm2	RME value for residential scenario.	USEPA, 1999.
		Soil to Skin Adherence Factor	0.2	mg/cm2	RME value for industrial scenario.	USEPA, 1999
		Exposure Frequency	175	days/yr	Works on-site 5 days/wk, 8 months/yr (35 weeks).	BPJ.
		Exposure Duration	25	years	Upper bound time for employment at a job.	USEPA, 1991, 1993.
		Averaging Time - Nc	9,125	days	25 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Ingestion of Groundwater	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Ingestion Rate	1	liter/day	Standard occupational ingestion rate.	USEPA, 1991.
		Exposure Frequency	175	days/yr	Works on-site 5 days/wk, 8 months/yr (35 weeks).	BPJ.
		Exposure Duration	25	years	Upper bound time for employment at a job.	USEPA, 1991, 1993
		Averaging Time - Nc	9,125	days	25 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Dermal Contact of Surface Water	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Skin Contact Surface Area	1,980	cm2	Adult male hands and forearms.	USEPA, 1992.
		Exposure Time	1	hour/day	Contact time during occasional site maintenance work.	BPJ.
		Exposure Frequency	18	days/yr	Assumes activity occurs 10% of work days.	BPJ.
		Exposure Duration	25	years	Upper bound time for employment at a job.	USEPA, 1991, 1993.
		Averaging Time - Nc	9,125	days	25 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Dermal Contact of Sediment	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Absorption Factor	Compound	Specific		USEPA, 1999.
		Skin Contact Surface Area	5,700	cm2	RME value for residential scenario.	USEPA, 1999.
		Soil to Skin Adherence Factor	0.2	mg/cm2	RME value for industrial scenario.	USEPA, 1999.
		Exposure Frequency	18	days/yr	Assumes activity occurs 10% of work days.	BPJ.
		Exposure Duration	25	years	Upper bound time for employment at a job.	USEPA, 1991, 1993.
		Averaging Time - Nc	9,125	days	25 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.

TABLE F-6
EXPOSURE FACTOR ASSUMPTIONS FOR CONSERVATION/RECREATIONAL LAND
SEAD-63 EE/CA
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	PARAMETER	RME		BASIS	SOURCE
			VALUE	UNITS		
RECREATIONAL VISITOR (CHILD)	Inhalation of Dust In Ambient Air	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991 1993.
		Inhalation Rate	8.7	m3/day	Average inhalation rate for a child 1-12 years old.	USEPA, 1997.
		Exposure Frequency	78	days/yr	Assumes 3 days/week during 13 summer weeks and 1 day/week for the remaining 39 weeks of the year.	BPJ
	(Air EPC Calculated from Surface Soil Only)	Exposure Duration	5	years	Assumed.	BPJ.
		Averaging Time - Nc	1,825	days	5 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Ingestion of Soil	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991, 1993.
		Ingestion Rate	200	mg soil/day	Maximum IR for a child.	USEPA, 1993.
	(Soil EPC Calculated from Surface Soil Only)	Fraction Ingested	1	(unitless)	100% ingestion, conservative assumption.	BPJ.
		Exposure Frequency	78	days/yr	Assumes 3 days/week during 13 summer weeks and 1 day/week for the remaining 39 weeks of the year.	BPJ.
		Exposure Duration	5	years	Assumed.	BPJ.
		Averaging Time - Nc	1,825	days	5 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Dermal Contact of Soil	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991, 1993.
		Absorption Factor	Compound	Specific		USEPA, 1999.
	(Soil EPC Calculated from Surface Soil Only)	Skin Contact Surface Area	2,800	cm2	RME value for residential child.	USEPA, 1999.
		Soil to Skin Adherence Factor	0.2	mg/cm2	RME value for residential child.	USEPA, 1999
		Exposure Frequency	78	days/yr	Assumes 3 days/week during 13 summer weeks and 1 day/week for the remaining 39 weeks of the year.	BPJ.
		Exposure Duration	5	years	Assumed.	BPJ.
		Averaging Time - Nc	1,825	days	5 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Inhalation of Groundwater	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991, 1993.
		Inhalation Rate	0.08	m3/day	Inhalation rate for sedentary children ages 3-10, 0.3 m3/hr for 15 minutes.	USEPA, 1997.
		Exposure Frequency	78	days/yr	Assumes 3 days/week during 13 summer weeks and 1 day/week for the remaining 39 weeks of the year.	BPJ.
		Exposure Duration	5	years	Assumed.	BPJ.
		Averaging Time - Nc	1,825	days	5 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Ingestion of Groundwater	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991, 1993.
		Ingestion Rate	1	liter/day	Approximate 90th percentile value for children 1-11 years old.	USEPA, 1997.
		Exposure Frequency	78	days/yr	Assumes 3 days/week during 13 summer weeks and 1 day/week for the remaining 39 weeks of the year.	BPJ.
		Exposure Duration				
		Averaging Time - Nc	5	years	Assumed.	BPJ.
		Averaging Time - Car	1,825	days	5 years.	
			25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Dermal Contact of Groundwater	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991, 1993.
		Skin Contact Surface Area	6,600	cm2	RME value for showering/bathing scenario.	USEPA, 1999.
		Exposure Time	1	hour/day	RME value for showering/bathing scenario.	USEPA, 1999.
		Exposure Frequency	78	days/yr	Assumes 3 days/week during 13 summer weeks and 1 day/week for the remaining 39 weeks of the year.	BPJ.
		Exposure Duration				
		Averaging Time - Nc	6	years	Assumed.	BPJ.
		Averaging Time - Car	1,625	days	5 years.	
			25,550	days	70 years, conventional human life span.	USEPA, 1989.

TABLE F-6
EXPOSURE FACTOR ASSUMPTIONS FOR CONSERVATION/RECREATIONAL LAND
SEAD-63 EE/CA
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	PARAMETER	RME		BASIS	SOURCE
			VALUE	UNITS		
RECREATIONAL VISITOR (CHILD - CONTINUED)	Dermal Contact of Surface Water	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991.
		Skin Contact Surface Area	3,300	cm2	Assumes skin contact surface as half of the total body surface during a wading event.	BPJ.
		Exposure Time	1	hour/day	RME value for showering/bathing scenario.	USEPA, 1999.
		Exposure Frequency	20	days/yr	Assumes wading occurs every time during 13 spring visits and 10% of other visits.	BPJ.
		Exposure Duration	5	years	Assumed.	BPJ.
		Averaging Time - Nc	1,825	days	5 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989
	Dermal Contact of Sediment	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991.
		Absorption Factor	Compound	Specific		USEPA, 1999
		Skin Contact Surface Area	2,800	cm2	RME value for soil contact by residential child.	USEPA, 1999.
		Soil to Skin Adherence Factor	0.2	mg/cm2	RME value for soil contact by residential child.	USEPA, 1999.
		Exposure Frequency	78	days/yr	Assumes 3 days/week during 13 summer weeks and 1 day/week for the remaining 39 weeks of the year.	BPJ.
		Exposure Duration	5	years	Assumed.	BPJ.
		Averaging Time - Nc	1,825	days	5 years.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.

TABLE F-6
EXPOSURE FACTOR ASSUMPTIONS FOR CONSERVATION/RECREATIONAL LAND
SEAD-63 EE/CA
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	PARAMETER	RME		BASIS	SOURCE
			VALUE	UNITS		
CONSTRUCTION WORKER	**Inhalation of Dust in Ambient Air**	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991
		Inhalation Rate	10.4	m3/day	Average inhalation rate for outdoor worker is 1.3 m3/hr, 8 hr work day	USEPA, 1997.
		Exposure Frequency	250	days/yr	Site specific based on land area	USEPA, 1991.
	(Air EPC Calculated from Surface and Subsurface Soils)	Exposure Duration	1	year	Upper bound time of employment for construction worker.	USEPA, 1991.
		Averaging Time - Nc	365	days	1 year.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Ingestion of Soil	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Ingestion Rate	480	mg soil/day	Assumed IR for intensive construction work.	USEPA, 1991, 1993
	(Soil EPC Calculated from Surface and Subsurface Soils)	Fraction Ingested	1	(unitless)	100% ingestion, conservative assumption.	BPJ.
		Exposure Frequency	250	days/yr	Site specific based on land area.	USEPA, 1991.
		Exposure Duration	1	year	Upper bound time of employment for construction worker.	USEPA, 1991.
		Averaging Time - Nc	365	days	1 year.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.
	Dermal Contact of Soil	Body Weight	70	kg	Standard reference weight for adults males.	USEPA, 1991.
		Absorption Factor	Compound	Specific		USEPA, 1999.
	(Soil EPC Calculated from Surface and Subsurface Soils)	Skin Contact Surface Area	3,300	cm2	RME value for industrial scenario.	USEPA, 1999.
		Soil to Skin Adherence Factor	0.3	mg/cm2	RME value for construction workers.	USEPA, 1999.
		Exposure Frequency	250	days/yr	RME value for industrial scenario.	USEPA, 1999.
		Exposure Duration	1	year	Upper bound time of employment for construction worker.	USEPA, 1991.
		Averaging Time - Nc	365	days	1 year.	
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989.

Notes:
RME = Reasonable Maximum Exposure
Car = Carcinogenic
Nc = Non-carcinogenic

Source References:
- BPJ: Best Professional Judgment.
- USEPA, 1988: Superfund Exposure Assessment Manual
- USEPA, 1989: Risk Assessment Guidance for Superfund, Volume I (RAGS)
- USEPA, 1991: Supplemental Guidance, Standard Default Exposure Factors
- USEPA, 1993: Superfund's Standard Default Exposure for the Central Tendency and Reasonable Maximum Exposure
- USEPA, 1997: Exposure Factors Handbook, Update to 1990 handbook
- USEPA, 1999: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance: Dermal Risk Assessment, Interim Guidance, 1999.

TABLE F- 6
EXPOSURE FACTOR ASSUMPTIONS FOR RESIDENTIAL SCENARIO
Decision Document - Mini Risk Assessment
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	PARAMETER	RME		BASIS	SOURCE
			VALUE	UNITS		
RESIDENT (ADULT)	Inhalation of Dust in Ambient Air (Air EPC Calculated from Surface Soil Only)	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Inhalation Rate	20	m3/day	Assumed inhalation rate for adult receptors	USEPA, 1991, 1993
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr	USEPA, 1991
		Exposure Duration	24	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Ingestion of Soil (Soil EPC Calculated from Surface Soil Only)	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Ingestion Rate	100	mg soil/day	Average residential adult exposure to indoor and outdoor dirt and dust	USEPA, 1991, 1993
		Fraction Ingested	1	(unitless)	100% ingestion, conservative assumption	BPJ
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr	USEPA, 1991
		Exposure Duration	24	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Dermal Contact of Soil (Soil EPC Calculated from Surface Soil Only)	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Absorption Factor	Compound	Specific		USEPA, 1999
		Skin Contact Surface Area	5,700	cm2	RME for residential adult exposed to soils.	USEPA, 1999.
		Soil to Skin Adherence Factor	0.07	mg/cm2	RME for residential adult exposed to soils.	USEPA, 1999
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr	USEPA, 1991
		Exposure Duration	24	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989.
	Inhalation of Groundwater	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Inhalation Rate	0.13	m3/day	Inhalation rate for sedentary adults, 0.5m3/hr for 15 minutes	USEPA 1997
		Exposure Frequency	365	days/yr	Showers 15 min/day 350 days/yr	BPJ
		Exposure Duration	24	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Ingestion of Groundwater	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Ingestion Rate	2	liter/day	90th percentile for adult residents	USEPA 1989
		Exposure Frequency	350	days/yr	Assumes year round exposure to gw and vacation from home for 2 wks/yr	BPJ.
		Exposure Duration	24	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Dermal Contact of Groundwater	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Skin Contact Surface Area	18,000	cm2	RME for residential adult for showering scenario	USEPA 1999
		Exposure Time	0.58	hours/day	RME for residential adult for showering scenario	USEPA, 1999
		Exposure Frequency	350	days/yr	Assumes year round exposure to gw and vacation from home for 2 wks/yr.	USEPA, 1991
		Exposure Duration	24	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult.	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Dermal Contact of Surface Water	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Skin Contact Surface Area	4,500	cm2	Assumes 25% of the total body surface exposured to water during wading	BPJ
		Exposure Time	0.5	hours/day	Assumption	BPJ
		Exposure Frequency	35	days/yr	Assumes 10% of the time ditch accumulates water	BPJ.
		Exposure Duration	24	years	Upper bound timo in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventioanl human life span	USEPA, 1989.
	Dermal Contact of Sediment	Body Weight	70	kg	Standard reference weight for adult males	USEPA, 1991
		Absorption Factor	Compound	Specific		USEPA, 1999
		Skin Contact Surface Area	5,700	cm2	RME for residential adult exposed to soil	USEPA, 1999
		Soil to Skin Adherence Factor	0.07	mg/cm2	RME for residential adult exposed to soil	USEPA, 1999
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr.	USEPA, 1991
		Exposure Duration	24	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	8,760	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventioanl human life span	USEPA, 1989.

TABLE F- 6
EXPOSURE FACTOR ASSUMPTIONS FOR RESIDENTIAL SCENARIO
Decision Document - Mini Risk Assessment
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	PARAMETER	RME		BASIS	SOURCE
			VALUE	UNITS		
RESIDENT (CHILD)	Inhalation of Dust in Ambient Air (Air EPC Calculated from Surface Soil Only)	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991 1993
		Inhalation Rate	8 7	m3/day	Average inhalation rate for a child 1-12 years old	USEPA, 1997
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr.	USEPA, 1991
		Exposure Duration	6	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	2,190	days	6 years.	USEPA, 1989
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Ingestion of Soil (Soil EPC Calculated from Surface Soil Only)	Body Weight	15	kg	Standard reference weight for children less than 6 years old	USEPA, 1991, 1993
		Ingestion Rate	200	mg soil/day	Maximum IR for a child	USEPA, 1993
		Fraction Ingested	1	(unitless)	100% ingestion, conservative assumption	BPJ
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr.	USEPA, 1991
		Exposure Duration	6	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	2,190	days	6 years	USEPA, 1989
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Dermal Contact of Soil (Soil EPC Calculated from Surface Soil Only)	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991, 1993
		Absorption Factor	Compound	Specific		USEPA, 1999
		Skin Contact Surface Area	2,800	cm2	RME value for residential child skin surface exposed to soil.	USEPA, 1999
		Soil to Skin Adherence Factor	0 2	mg/cm2	RME value for residential child exposed to soil	USEPA, 1999
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr	USEPA, 1991
		Exposure Duration	6	years	Upper bound time in 1 residence 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	2,190	days	6 years	USEPA, 1989
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989
	Inhalation of Groundwater	Body Weight	15	kg	Standard reference weight for children less than 6 years old	USEPA, 1991, 1993
		Inhalation Rate	0 08	m3/day	Inhalation rate for sedentary children ages 3-10, 0 3 m3/hr for 15 minutes.	USEPA, 1997
		Exposure Frequency	3 65	days/yr	Showers 15 min/day, 350 days/yr.	BPJ.
		Exposure Duration	6	years	Upper bound time in 1 residence. 6 years as a child, 24 years as an adult.	USEPA, 1991, 1993.
		Averaging Time - Nc	2,190	days	6 years	USEPA, 1989
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA. 1989
	Ingestion of Groundwater	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991, 1993
		Ingestion Rate	1	liter/day	Approximate 90th percentile value for children 1-11 years old.	USEPA. 1997.
		Exposure Frequency	350	days/yr	Assumes year round exposure to gw and vacation from home for 2 wks/yr.	USEPA, 1991
		Exposure Duration	6	years	Upper bound time in 1 residence: 6 years as a child, 24 years as an adult.	USEPA, 1991, 1993
		Averaging Time - Nc	2,190	days	6 years	USEPA, 1989
		Averaging Time - Car	25,550	days	70 years, conventional human life span.	USEPA, 1989
	Dermal Contact of Groundwater	Body Weight	15	kg	Standard reference weight for children less than 6 years old	USEPA, 1991, 1993
		Skin Contact Surface Area	6,600	cm2	RME value for residential child during showering.	USEPA, 1999
		Exposure Time	1.0	hours/day	RME value for residential child for showering scenario.	USEPA, 1999
		Exposure Frequency	350	days/yr	Assumes year round exposure to gw and vacation from home for 2 wks/yr.	USEPA, 1991
		Exposure Duration	6	years	Upper bound time in 1 residence: 6 years as a child, 24 years as an adult	USEPA, 1991, 1993
		Averaging Time - Nc	2,190	days	6 years	USEPA, 1989
		Averaging Time - Car	25,550	days	70 years, conventional human life span	USEPA, 1989
	Dermal Contact of Surface Water	Body Weight	15	kg	Standard reference weight for children less than 6 years old.	USEPA, 1991
		Skin Contact Surface Area	3,300	cm2	Assumes skin contact surface as half of total body surface while wading	BPJ
		Exposure Time	1	hours/day	RME value for showering/bathing scenario	USEPA, 1999
		Exposure Frequency	35	days/yr	Assumes 10% of the time ditch accumulates water.	BPJ.
		Exposure Duration	6	years	Upper bound time in 1 residence: 6 years as a child, 24 years as an adult.	USEPA, 1991, 1993
		Averaging Time - Nc	2,190	days	6 years	
		Averaging Time - Car	25,550	days	70 years, conventioanl human life span.	USEPA, 1989.
	Dermal Contact of Sediment	Body Weight	15	kg	Standard reference weight for adult males	USEPA, 1991
		Absorption Factor	Compound	Specific		USEPA, 1999
		Skin Contact Surface Area	2,800	cm2	RME for residential adult exposed to soil.	USEPA, 1999.
		Soil to Skin Adherence Factor	0.2	mg/cm2	RME for residential adult exposed to soil.	USEPA, 1999.
		Exposure Frequency	350	days/yr	Assumes year round exposure to soil and vacation from home for 2 wks/yr.	USEPA, 1991.
		Exposure Duration	6	years	Upper bound time in 1 residence: 6 years as a child, 24 years as an adult.	USEPA, 1991, 1993.
		Averaging Time - Nc	2,190	days	24 years	
		Averaging Time - Car	25,550	days	70 years, conventioanl human life span	USEPA, 1989.

TABLE F-6
EXPOSURE FACTOR ASSUMPTIONS FOR RESIDENTIAL SCENARIO
Decision Document - Mini Risk Assessment
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	PARAMETER	RME		BASIS	SOURCE
			VALUE	UNITS		

Notes:
RME = Reasonable Maximum Exposure
Car = Carcinogenic
Nc = Non-carcinogenic

Source References:
BPJ Best Professional Judgement
- USEPA, 1988 Superfund Exposure Assessment Manual
- USEPA, 1989. Risk Assessment Guidance for Superfund, Volume I (RAGS)
- USEPA, 1991: Supplemental Guidance, Standard Default Exposure Factors
- USEPA, 1993 Superfund's Standard Default Exposure for the Central Tendency and Reasonable Maximum Exposure
- USEPA, 1997: Exposure Factors Handbook, Update to 1990 handbook
- USEPA, 1999 Risk Assessment Guidance for Superfund, Volume I. Human Health Evaluation Manual, Supplemental Guidance: Dermal Risk Assessment, Interim Guidance, 1999

The primary sources for the RME and CT exposure factors are as follows:

- USEPA, 1988: Superfund Exposure Assessment Manual
- USEPA, 1989a: Risk Assessment Guidance for Superfund, Volume I (RAGS)
- USEPA, 1991a: Supplemental Guidance, Standard Default Exposure Factors
- USEPA, 1992: Dermal Exposure Assessment, Principles and Applications
- USEPA, 1993a: Superfund's Standard Default Exposure for the Central Tendency and Reasonable Maximum Exposure
- USEPA, 1997: Exposure Factors Handbook
- USEPA, 1999: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplement Guidance: Dermal Risk Assessment, Interim Guidance

In the following sections, the methods used to calculate exposures by each pathway are explained. Tables, which show the human intake or absorbed dose values calculated for each exposure scenario, are contained in **Attachment A** of this appendix. These intakes and doses are used to assess overall carcinogenic and non-carcinogenic risk, as discussed later in the risk characterization section (**Section F.5**).

F3.5.2 Exposure Scenarios

The exposure scenarios for the four receptors and their respective exposure assumptions in this assessment are described below.

Construction Worker. Future construction workers are assumed to spend one year working at the site, which is a typical duration for a significant construction project. These workers spend each working day at the site. During this time, this worker inhales the ambient air at the site and may ingest or dermally contact the soil there. Since the construction worker may be digging onsite, the soil ingestion or dermal contact with both surface and subsurface soils was assumed.

Park Worker. The park worker's work schedule differs from other workers discussed above. The park worker is assumed to work onsite for only 8 months (35 weeks) per year from Spring through Autumn, when recreational visitors would use the conservation area. The workday (8 hours/day) and exposure duration (25 years) are the same as other workers. Like the industrial, warehouse and day care workers, the park worker inhales the ambient air, ingests groundwater, and ingests and dermally contacts surface soil. In addition, the park worker may occasionally dermally contact surface water and sediment in the conservation area.

Recreational Visitor (Child). While both adults and children may visit the conservation area, potential risks would be expected to be higher for children, due to their higher soil ingestion rates and lower body weights. To be conservative, a child recreational visitor receptor is assessed. The recreational visitor is assumed to visit the conservation area 3 days/week during 13 summer weeks, and 1 day/week for the remaining 39 weeks of the year for a total exposure frequency of 78 days/year for 5 years. During each visit, the child inhales the ambient air, ingests groundwater, inhales and dermally contacts groundwater during showering, ingests and dermally contacts surface soil, dermally contacts ditch sediment. In addition, the child recreational visitor may occasionally dermally contact surface water in the conservation area.

Resident. Potential risks for a residential adult and child were evaluated for comparative purposes only. Cancer risks for the residential adult and child were summed to present a lifetime cancer risk for a resident. Risks from exposure via dust inhalation, soil ingestion and dermal contact, groundwater ingestion, inhalation, and dermal contact, and surface water and sediment dermal contact were evaluated. Exposure factors are presented in **Table F-6**.

Complete exposure assumptions (exposure factors) for all receptors and exposure scenarios are summarized in Table F-6. Most exposure factors used in the exposure assessment were obtained from EPA guidance documents. Other exposure factors were based on conservative professional judgment where no data are available form EPA or other sources.

F.3.5.3 Inhalation of Particulate Matter in Ambient Air

This pathway consists of particulate matter (PM) being released from soils to the air and then being inhaled by future receptors. Ambient PM concentrations for a construction worker were estimated using an emission and dispersion model. PM concentrations for the park worker, recreational visitor, and residential receptors were based on existing site air measurements shown in **Table F-7.**

Construction Worker

During construction activities, construction workers may be exposed to chemicals in site soils via inhalation. Construction activities, such as excavation, have the potential to create dust, or suspended particulate matter (PM), originating from the soils being removed. This dust would contain the chemicals present in the soil. Construction workers in the construction area would breathe this PM in the ambient air.

TABLE F-7
SUSPENDED PARTICULATE CONCENTRATIONS MEASURED AT SEDA
SEAD-63 EE/CA
Seneca Army Depot Activity

PARTICULATE DATA	SITE #1 PM 10	SITE #2 PM 10	SITE #3 PM 10	SITE #4 PM 10
Peak Concentration (ug/m3)	37 on 23 July 95	37 on 23 July 95	37 on 5 July 95	37 on 5 July 95
Arithmetic Mean (ug/m3)	16.9	16.6	16.4	15.8
Standard Deviation	21.4	21.1	23.0	23.0
Geometric Mean (ug/m3)	15.1	14.8	14.8	14.2
No. of 24-hr. Avgs. Above 150 ug/m3	0	0	0	0
Number of Valid Samples	29	32	29	31
Percent Data Recovery	90.6	100.0	90.6	96.9

ulative Summary for April 1, 1995 through July 31, 1995

Air concentrations of site chemicals of concern were estimated for this exposure pathway using excavation models recommended in the USEPA's "Models for Estimating Air Emission Rates from Superfund Remedial Actions" (EPA 451/R-93-001). Particulate emissions from soil excavation and loading into trucks are estimated with the following equation:

$$E = \frac{k\ (0.0016)\ (M)\ [\ U/2.2\ ]^{1.3}}{[\ X/2\ ]^{1.4}}$$

Where:

E = emissions (g)
k = particle size multiplier (unitless)
0.0016 = empirical constant (g/kg)
M = mass of soil handled (kg)
U = mean wind speed (m/sec)
2.2 = empirical constant (m/sec)
X = percent moisture content (%)

The construction worker receptor is assumed to work at the site for a one year period. To conservatively estimate potential particulate emissions from construction activities during this period, it was assumed that the entire area of the site (an approximate 4 acre area) is excavated to a depth of two meters over the course of one year as part of the site construction. This results in the following mass of soil removed:

Mass = Area x Depth x Soil Bulk Density

= 16,188 square meters x 2 meters x 1.5 g/cm^3 x 10^6 cm^3/m^3
= 4.856 x 10^{10} grams
= 4.856 x 10^7 kg

Other parameter values for the model are as follows:

k = 0.35 for PM_{10} (EPA 1993)
U = 4.4 m/sec, average wind speed for Syracuse, NY (EPA 1985)
X = 10%, recommended default (EPA 1993)

With these values for M, k, U and X, the emission rate (E) from excavation activities is calculated 7,035 grams of PM_{10} over the course of a year. This emission rate would be representative if all soil excavated at the site were contaminated, and if local climatic factors did not suppress emissions. For example, precipitation, snow cover and frozen soil in the winter will minimize emissions. To account for these climatic/seasonal factors, it was assumed that emissions occur only half of the construction time. This results in a representative emission rate (E) of 3,517 grams/year. This is equivalent to an average emission rate of 14 g/day, 1.75 g/hr or 0.49 mg/sec, assuming emission occurs only during work days: 250 days/yr, 8 hr/day.

Much greater short-term emissions are estimated for site grading with a bulldozer or tractor. This type of activity is assumed to occur for 90 work days (8-hour day) over the course of a year. The model equation for grading emissions is:

$$E = \frac{0.094\,(s)^{1.5}}{X^{1.4}}$$

Where:

E	=	emission rate (g/sec)
0.094	=	empirical constant (g/sec)
s	=	percent silt content (%)
X	=	percent moisture content (%)

Assuming the EPA-recommended default values of 8% for s, and 10% for X, the emission rate (E) from grading is calculated as 0.085 g/sec. Averaged over the course of a year with 90 8-hour days of grading emissions, this is 38.1 g/hr or 10.6 mg/sec of PM_{10} emissions, assuming all emissions occur during working hours.

Total annual average emissions from excavation and grading are estimated as 0.49 mg/sec + 10.6 mg/sec = 11.09 mg/sec.

Localized exposure concentrations for construction workers are estimated with a simple box model. The model treats a defined surface area as a uniform emission source over the time period of interest. The box, or mixing volume, is defined by this surface area and an assumed mixing height. The emitted PM_{10} is assumed to mix uniformly throughout the box, with dilution from surface winds.

The general model equation is:

$$C = \frac{E}{(U)(W)(H)}$$

Where:

E = emission rate, mg/sec
U = wind speed, m/sec
W = crosswind width of the area source, m
H = mixing height, m

E and U are the same as defined or calculated above. The mixing area is based upon the area of the site estimated to be excavated during one hour. The area of SEAD-63, 16,188 square meters, may be excavated during 2000 hours of construction activity. The average hourly area worked then is: 16,188 ÷ 2000 = 8 square meters. This area is assumed to be square, and W is the square root of 8 m^2, or 2.8 meters. H is assumed to be the height of the breathing zone, or 1.75 meters.

With these values, the PM_{10} exposure concentration for a construction worker is calculated as 0.51 mg/m^3. All of this PM_{10} was assumed to be airborne soil released from the site as represented by total soils (surface and subsurface).

The concentration of particulate-associated chemicals in ambient air, then, is:

$$\mathbf{CA = CS \times PM_{10} \times CF}$$

Where:

CA = chemical concentration in air (mg/m^3)
CS = chemical concentration in soil (mg/kg soil)
PM_{10} = PM_{10} concentration (ug/m^3)
CF = conversion factor (10^{-9} kg/ug)

These calculated CA values are the inhalation EPCs for the dust inhalation scenarios. **Table A-1** (in **Attachment A**) show the inhalation EPCs for the future construction workers.

Park Worker, Recreational Visitor, and Residential Receptors

Ambient air normally contains particulate matter derived from various natural and anthropogenic sources, including soil erosion, fuel burning, automobiles, etc. The concentrations of airborne particulate matter were measured at SEDA over a four month period (April-July) in 1995. A summary of the data collected in this air sampling program is shown in **Table F-7**. Both Total Suspended Particulate Matter (TSP) and particulate matter less than 10µm aerodynamic diameter (PM_{10}) were measured. TSP includes all particles that can remain suspended in air, while PM_{10}

includes only smaller particles that can be inhaled (particles larger than 10µm diameter typically cannot enter the narrow airways in the lung).

For this assessment, the highest 4-month average PM_{10} concentration measured at any of the four monitoring stations was assumed to represent ambient air at the site. The entire particulate loading was assumed to be airborne soil released from SEAD-63 as represented by the surface soil EPCs for the site.

The concentration of particulate-associated chemicals in ambient air, (CA), was calculated with the same equation [$CA = CS \times PM_{10} \times CF$] used for the construction worker, above.

The ambient air exposure point concentrations used in the intake calculations are shown in **Attachment A.**

The equation for intake is as follows (EPA, 1989a):

$$\textbf{Intake (mg/kg/day)} = \frac{\mathbf{CA \times IR \times EF \times ED}}{\mathbf{BW \times AT}}$$

Where:

CA = Chemical concentration in air (mg/m^3)
IR = Inhalation Rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Bodyweight (kg)
AT = Averaging Time (days)

The results of these calculations are shown in **Attachment A**.

F.3.5.4 Incidental Ingestion of Soil

The soil data collected from SEAD-63 were compiled and the EPCs were selected for each compound. For the park worker, recreational visitor, and residential receptor exposures, soil data collected from the 0 to 2 foot interval were used in this analysis, since no surface soil samples were collected. For the construction worker exposure, all soil data were used as it is assumed that the construction worker will engage in intrusive activities.

The equation for intake is as follows (EPA 1989a):

$$\textbf{Intake (mg/kg-day)} = \frac{\textbf{CS x IR x CF x FI x EF x ED}}{\textbf{BW x AT}}$$

Where:

CS = Chemical Concentration in Soil (mg/kg soil)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (1 Kg/10^6 mg)
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

The results of these calculations are shown in **Attachment A.**

F.3.5.5 Dermal Contact with Soils/Sediments

The same receptors considered to have the potential to ingest soil may also contact the same soils dermally. These receptors include the park worker, construction worker, recreational visitor, and residential receptors. Risks due to exposure to sediments via dermal contact for park workers, recreational visitors, and residential receptors were also evaluated.

As with the soil ingestion scenarios, the chemical concentration of the soils taken from the 0 to 2 foot depth were used as the exposure point concentrations for the park worker and recreational visitor. The chemical concentration of all soils was used as the exposure point concentration for the construction worker scenario. The measured maximum sediment concentrations were used as exposure point concentrations for the park worker and recreational visitor.

The equation for the absorbed dose from dermal exposure is as follows, based on guidance in EPA 1992:

$$\textbf{Absorbed Dose (mg/kg-day)} = \frac{\textbf{CS x CF x AF x ABS x SA x EF x ED}}{\textbf{BW x AT}}$$

Where:

CS = Chemical Concentration in Soil/Sediment (mg/kg soil)
CF = Conversion Factor (10^{-6} kg/mg)
AF = Soil to Skin Adherence Factor (mg/cm^2)

ABS = Absorption Factor (unitless)
SA = Skin Surface Area Available for Contact (cm^2)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

The product of the terms CS, AF, and ABS represents the absorbed dose per event as defined in the EPA 1992 guidance.

The exposure calculations are summarized in **Attachment A.**

Dermal exposure involves several unique exposure factors discussed briefly here. Specifically, the dermal exposure calculation considers the amount of exposed skin, the amount of soil/sediment that adheres to the skin and the degree to which a chemical may be adsorbed through the skin.

The surface area of exposed skin depends on the size of an individual (especially adult vs. child), clothing worn, and the specific parts of the body that may directly contact the medium of concern (e.g., soil or groundwater during showering). USEPA recommendations were followed to select exposed skin surface areas for each scenario in this assessment.

The assumptions for dermal exposure are listed in Table F-6. Selected assumptions regarding skin surface areas for dermal exposure for construction worker, park worker, and recreational visitor receptors are presented as follows:

Construction Worker (Soil): The construction worker was assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed skin surface is limited to the head, hands, and forearms. The USEPA's recommended surface area exposed to contaminated soil for the adult commercial/industrial receptor, 3300 cm^2 (USEPA, 1999), was used to represent the RME scenario for the construction worker.

Park Worker (Soil/Sediment): The park worker was conservatively assumed to address the same as an adult resident, wearing a short-sleeved shirt, shorts and shoes. Therefore, the exposed skin surface is limited to the head, hands, forearms, and lower legs. The USEPA (1999) recommended value of 5700 cm^2 for the adult residential receptor was used to represent the RME scenario for the parker worker.

Recreational Visitor - Child (Soil/Sediment): The recreational child was assumed to wear a short-sleeved shirt and shorts (no shoes) and therefore, the exposed skin is limited to the head, hands, forearms, lower legs, and feet. The recommended surface area exposed to contaminated soil for the child is 2800 cm^2 for a RME scenario (USEPA, 1999).

The potential magnitude of exposure depends on the amount of soil that adheres to the exposed skin. Certain chemicals may be readily absorbed through the skin while others penetrate much more slowly or not at all. In the case of soil, some chemicals may be strongly bound to the matrix, which reduces their ability to absorb through the skin. Chemical-specific absorption factors as provided by USEPA (1999) were used in this assessment. USEPA (1999) recommends dermal absorption fraction from soil for cadmium, arsenic, chlordane, DDT, Lindane, PAHs, PCBs, dioxins/furans, 2,4-Dichlorophenoxyacetic acid. and pentachorophenol. The USEPA 1999 guidance also provides default dermal absorption factors for semivolatile organic compounds of 10% as a screening method for the majority of SVOCs without dermal absorption factors. There are no default dermal absorption values presented for volatile organic compounds nor inorganic classes of compounds. The uncertainty related to the dermal exposure route will be addressed in the uncertainty assessment section (F.5.4).

F.3.5.6 Groundwater Ingestion

All future receptors may drink groundwater. The groundwater data collected from the site were compiled and the EPCs were selected for each compound.

The equation for intake is as follows (EPA. 1989a):

$$\textbf{Intake (mg/kg-day)} = \frac{\textbf{CW x IR x EF x ED}}{\textbf{BW x AT}}$$

Where:

CW = Chemical Concentration in Water (mg/liter)
IR = Ingestion Rate (liters/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Bodyweight (kg)
AT = Averaging time (days)

The results of these calculations are shown in **Attachment A.**

F.3.5.7 Dermal Contact to Groundwater or Surface Water while Showering/Bathing/Wading

Recreational visitors may be exposed to groundwater while showering/bathing. Risks to residential receptors via dermal contact with groundwater or surface water while showering/bathing/wading were evaluated for comparative purposes only. The EPCs developed for ingestion of groundwater were used for this exposure route. Recreational visitors may also be exposed to surface water in the ditches during a wading event. The measured maximum surface water concentrations were used as EPCs for this scenario. The equation for the absorbed dose, taken from RAGS (EPA, 1989a) is as follows:

$$\textbf{Absorbed Dose (mg/kg-day)} = \frac{\textbf{DA x SA x EF x ED}}{\textbf{BW x AT}}$$

Where:

DA	=	Absorbed dose per event per area of skin exposed (mg/cm^2 - event)
SA	=	Skin surface area available for Contact (cm^2)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged, days)

DA (mg/cm^2 - event) was calculated as described in USEPAs Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance: Dermal Risk Assessment Interim Guidance (USEPA, 1999). The following equations were used to evaluate the dermal absorbed dose per event per area of skin exposed:

For organic compounds:

If ET ≤ t*, then: $$\mathbf{DA = 2\ K_p\ x\ CW\ x\ CF}\sqrt{\frac{6\times\tau\times ET}{\pi}}$$

If ET > t*, then: $$\mathbf{DA_{event} = K_p\ x\ CW\ x\ CF}\left[\frac{ET}{1+B}+2\tau\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

where for both equations:

K_p = Dermal permeability coefficient (cm/hr)
CW = Chemical Concentration in Water (mg/l)
ET = Exposure Time (hours/event)
B = Dimensionless ratio of the permeability of the stratum corneum relative to the permeability across the viable epidermis (and any other limitations to chemical transfer through the skin, including clearance into the cutaneous blood).
τ = Lag time per event (hours/event)
t* = Time to reach steady-state (hr) = 2.4τ
CF = Volume Conversion Factor = 0.001L/cm^3

The exposure time for showering or wading was assumed to be 1 hour/day for the RME, as recommended in the Dermal Risk Assessment Interim Guidance (USEPA, 1999) for the showering scenario. The entire body surface may be exposed during showering. EPA 1999 recommends a surface area value of 6600 cm^2 for the RME as representative of the entire body of a child. For the wading scenario, skin contact surface was conservatively assumed to be as half of the total body surface, 3300 cm^2.

Lag times per event (τ), B, and Kp were taken from a list in Table B.2 of the Dermal Risk Assessment Interim Guidance. All chemicals not having lag times were derived using the following equation:

$$\tau = \frac{l_{sc}^2}{6D_{sc}}$$

where:

l_{sc} = Apparent thickness of skin, assumes 0.001 cm
D_{sc} = Effective diffusivity for chemical transfer through the skin (cm^2/hr), $D_{sc} = l_{sc} \times 10^{(-2.80-0.0056MW)}$
MW = Molecular weight of the compound.

When no organic K_p value was available, a value was calculated using the following equation:

$$\text{Log } K_p = -2.80 + 0.67 \log K_{ow} - 0.0056 \text{ MW}$$

Where:

Kow = Octanol/water partition coefficient

For inorganics, DA was calculated by:

$$DA = K_p \times CW \times ET \times CF$$

Kp values for inorganic chemicals were taken from Table 3.1 of the Dermal Risk Assessment Interim Guidance (USEPA, 1999). As recommended by USEPA (1999), a default value of 1 x 10^{-3} cm/hr was used for all inorganics with no specific Kp values.

Exposure to chemicals in groundwater during showering occurs via two routes: inhalation of volatile chemicals, which partition into the air from the hot shower water, and dermal contact. The analysis of these two exposure routes assumes that release of volatile chemicals to the air occurs quickly, and that only the quantities which remain in the water stream are available for dermal contact. The calculations of exposure from inhalation assume that the water from the shower nozzle has the same concentration as groundwater, and the groundwater EPC is used. However, for dermal contact, the EPCs are most correctly first adjusted to subtract the amount of each chemical that partitions into the air. This adjustment prevents "double counting" the potential effect of the portion of certain chemicals that escape the water into the air of the shower.

For SEAD-63, the groundwater EPC was not adjusted to account for volatile losses during showering before considering dermal exposure. Although inhalation and dermal exposures from showering were assessed for SEAD-63, volatile losses during showering were determined to be one percent or less for any compound, and there were no toxicity factors for any compounds which might be inhaled during showering. For simplicity, the groundwater EPC was used directly to assess dermal exposures from shower water for this site.

The dermal exposure calculations, where applicable, are summarized in **Attachment A.**

F.3.5.8 Inhalation of Groundwater or Surface Water while Showering/Bathing

While showering, a receptor may inhale organic compounds released from the hot water supply. Most inorganic compounds potentially found in groundwater, such as metals, are nonvolatile. Therefore, this pathway is not complete for inorganics in water.

No volatile organic compounds were detected in the groundwater at SEAD-63. Therefore, this pathway was not evaluated further in this risk assessment.

F.4 Toxicity Assessment

The objective of the toxicity assessment is to weigh available evidence regarding the potential of the chemicals to cause adverse effects in exposed individuals, and to provide, where possible, an estimate of the relationship between the extent of exposure to a chemical and the increased likelihood and/or severity of adverse effects. The types of toxicity information considered in this assessment include the reference dose (RfD) and reference concentration (RfC) used to evaluate noncarcinogenic effects, and the slope factor and unit risk to evaluate carcinogenic potential. Most toxicity information used in this evaluation was obtained from the Integrated Risk Information System (IRIS). If values were not available from IRIS, the *Health Effects Assessment Summary Tables* (HEAST) (EPA, 1997) were consulted. Finally, the toxicity values withdrawn from IRIS and other values quoted by EPA Region III RBC table USEPA were consulted to provide any additional values not included in these two sources. The toxicity factors used in this evaluation are summarized in **Table F-8** for both noncarcinogenic and carcinogenic effects.

F.4.1 Noncarcinogenic Effects

For chemicals that exhibit noncarcinogenic (i.e., systemic) effects, authorities consider organisms to have repair and detoxification capabilities that must be exceeded by some critical concentration (threshold) before the health effect is manifested. For example, an organ can have a large number of cells performing the same or similar functions that must be significantly depleted before the effect on the organ is seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects. Health criteria for chemicals exhibiting noncarcinogenic effects for use in risk assessment are generally developed using USEPA RfDs and RfCs developed by the RfD/RfC Work Group and included in the IRIS. In general, the RfD/RfC is an estimate of an average daily exposure to an individual (including sensitive individuals) below

TABLE F-8
TOXICITY VALUES
SEAD-63 EE/CA
Seneca Army Depot Activity

Analyte	Oral RfD (mg/kg-day)		Inhalation RfD (mg/kg-day)		Carc. Slope Oral (mg/kg-day)-1		Rank Wt. of Evidence	Carc. Slope Inhalation (mg/kg-day)-1		Dermal RfD (mg/kg-day)		Carc. Slope Dermal (mg/kg-day)-1		Oral Absorption Factor	
Volatile Organics															
Acetone	1.00E-001	a	NA	a	NA	a	D	NA	a	1.00E-001	f	NA		1.00	j
Benzene	3.00E-003	i	1.71E-003	i	2.90E-002	a	A	2.73E-002	a	3.00E-003	f	2.90E-002	g	1.00	j
Chloroform	1.00E-002	a	NA	a	6.10E-003	a	B2	8.05E-002	a	1.00E-002	f	6.10E-003	g	1.00	j
Methyl ethyl ketone	6.00E-001	a	2.86E-001	a	NA	a	D	NA	a	6.00E-001	f	NA		1.00	j
Toluene	2.00E-001	a	1.14E-001	a	NA	a	D	NA	a	2.00E-001	f	NA		1.00	j
Total Xylenes	2.00E+000	a	NA	c	NA	a	D	NA	a	2.00E+000	f	NA		1.00	j
Semivolatiles*															
4-Methylphenol	5.00E-003	b	NA	a	NA	a	C	NA	a	NA		NA		1.00	j
Benzo(a)anthracene	NA	a	NA	a	7.30E-001	c	B2	NA	a	NA		7.30E-001	g	1.00	j
Benzo(a)pyrene	NA	a	NA	a	7.30E+000	a	B2	NA	a	NA		7.30E+000	g	1.00	j
Benzo(b)fluoranthene	NA	a	NA	a	7.30E-001	c	B2	NA	a	NA		7.30E-001	g	1.00	j
Benzo(ghi)perylene	NA	a	NA	a	NA	a	D	NA	a	NA		NA		1.00	j
Benzo(k)fluoranthene	NA	a	NA	a	7.30E-002	c	B2	NA	a	NA		7.30E-002	g	1.00	j
Butylbenzylphthalate	2.00E-001	b	NA	a	NA	a	C	NA	a	2.00E-001	f	NA		1.00	j
Carbazole	NA	a	NA	a	2.00E-002	b	B2	NA	a	NA		2.00E-002	g	1.00	j
Chrysene	NA	a	NA	a	7.30E-003	c	B2	NA	a	NA		7.30E-003	g	1.00	j
Dibenz(a,h)anthracene	NA	a	NA	a	7.30E+000	c	B2	NA	a	NA		7.30E+000	g	1.00	j
Dibenzofuran	NA	a	NA	a	NA	a	D	NA	a	NA		NA		1.00	j
Diethyl phthalate	8.00E-001	b	NA	a	NA	a	D	NA	a	8.00E-001	f	NA		1.00	j
Di-n-butylphthalate	1.00E-001	a	NA	a	NA	a	D	NA	a	1.00E-001	f	NA		1.00	j
Di-n-octylphthalate	2.00E-002	b	NA	a	NA	a	NA	NA	a	NA		NA		1.00	j
Fluoranthene	4.00E-002	a	NA	a	NA	a	D	NA	a	4.00E-002	f	NA		1.00	j
Fluorene	4.00E-002	a	NA	a	NA	a	D	NA	a	4.00E-002	f	NA		1.00	j
Indeno(1,2,3-cd)pyrene	NA	a	NA	a	7.30E-001	c	B2	NA	a	NA		7.30E-001	g	1.00	j
Naphthalene	2.00E-002	a	8.60E-004	a	NA	a	C	NA	a	2.00E-002	f	NA		1.00	j
Pentachlorophenol	3.00E-002	a	NA	a	1.20E-001	a	B2	NA	a	3.00E-002	f	1.20E-001	g	1.00	j
Phenanthrene	NA	a	NA	a	NA	a	D	NA	a	NA		NA		1.00	j
Phenol	6.00E-001	a	NA	a	NA	a	D	NA	a	6.00E-001	f	NA		1.00	j
Pyrene	3.00E-002	a	NA	a	NA	a	D	NA	a	3.00E-002	f	NA		1.00	j
bis(2-Ethylhexyl)phthalate	2.00E-002	a	NA	a	1.40E-002	a	B2	NA	a	2.00E-002	f	1.40E-002	g	1.00	j
Pesticides/PCBs															
4,4'-DDD	NA	a	NA	a	2.40E-001	a	B2	NA	a	NA		2.40E-001	g	1.00	j
4,4'-DDE	NA	a	NA	a	3.40E-001	a	B2	NA	a	NA		3.40E-001	g	1.00	j
4,4'-DDT	5.00E-004	a	NA	a	3.40E-001	a	B2	3.40E-001	a	5.00E-004	f	3.40E-001	g	1.00	j
Aroclor-1260	2.00E-005	l	NA	a	2.00E+000	a	B2	4.00E-001	a	2.00E-005	f	2.00E+000	g	1.00	j
Endosulfan I	6.00E-003	n	NA	a	NA	a	NA	NA	a	6.00E-003	f	NA		1.00	j
Endosulfan sulfate	6.00E-003	n	NA	a	NA	a	NA	NA	a	6.00E-003	f	NA		1.00	j
Endrin	3.00E-004	a	NA	a	NA	a	D	NA	a	3.00E-004	f	NA		1.00	j
Endrin aldehyde	NA	a	NA	a	NA	a	NA	NA	a	NA		NA		1.00	j
Endrin ketone	NA	a	NA	a	NA	a	NA	NA	a	NA		NA		1.00	j
Heptachlor epoxide	1.30E-005	a	NA	a	9.10E+000	a	B2	9.10E+000	a	1.30E-005	f	9.10E+000	g	1.00	j
alpha-Chlordane	5.00E-004	o	2.00E-004	o	3.50E-001	o	B2	3.50E-001	o	5.00E-004	f	3.50E-001	g	1.00	j
gamma-Chlordane	5.00E-004	o	2.00E-004	o	3.50E-001	o	B2	3.50E-001	o	5.00E-004	f	3.50E-001	g	1.00	j
Metals															
Aluminum	1.00E+000	i	1.00E-003	i	NA	a	D	NA	a	1.00E+000	f	NA		1.00	j
Arsenic	3.00E-004	a	NA	c	1.50E+000	d	A	1.51E+001	a	3.00E-004	f	1.50E+000	g	1.00	j
Barium	7.00E-002	a	1.43E-004	b	NA	a	D	NA	a	4.90E-003	f	NA		0.07	j
Beryllium	2.00E-003	a	6.00E-006	a	NA	a	B2	8.40E+000	a	1.40E-005	f	NA		0.007	j
Cadmium	5.00E-004	p	NA	a	NA	a	B1	6.30E+000	a	1.25E-005	f	NA		0.025	k,j
Calcium	NA	a	NA	a	NA	a	NA	NA	a	NA		NA		1.00	j
Chromium	3.00E-003	q	2.86E-005	q	NA	a	A	4.20E+001	q	7.50E-005	f	NA		0.025	q,j
Cobalt	2.00E-002	m	5.00E-006	a	NA	a	NA	NA	a	2.00E-002		NA		1.00	j
Copper	4.00E-002	b	NA	a	NA	a	D	NA	a	4.00E-002	f	NA		1.00	j
Iron	3.00E-001	e	NA	a	NA	a	NR	NA	a	3.00E-001	f	NA		1.00	j
Lead	NA	a	NA	a	NA	a	B2	NA	a	NA		NA		1.00	j
Magnesium	NA	a	NA	a	NA	a	D	NA	a	NA		NA		1.00	j
Manganese	5.00E-002	r	1.40E-005	a	NA	a	D	NA	a	2.00E-003	f	NA		0.04	j
Mercury	3.00E-004	s	8.57E-005	a	NA	a	D	NA	a	2.10E-005	f	NA		0.07	s,j
Nickel	2.00E-002	a	NA	a	NA	a	NR	NA	a	8.00E-004	f	NA		0.04	j
Potassium	NA	a	NA	a	NA	a	NA	NA	a	NA		NA		1.00	j
Selenium	5.00E-003	a	NA	a	NA	a	D	NA	a	5.00E-003	f	NA		1.00	j
Silver	5.00E-003	a	NA	a	NA	a	D	NA	a	2.00E-004	f	NA		0.04	j
Sodium	NA	a	NA	a	NA	a	NA	NA	a	NA		NA		1.00	j
Thallium	8.00E-005	t	NA	a	NA	a	D	NA	a	8.00E-005	f	NA		1.00	j
Vanadium	7.00E-003	b	NA	a	NA	a	D	NA	a	1.82E-004	f	NA		0.026	j
Zinc	3.00E-001	a	NA	a	NA	a	D	NA	a	3.00E-001	f	NA		1.00	j

a = Taken from the Integrated Risk Information System (IRIS) (Online October 2001)

b = Taken from HEAST 1997

c = Calculated using TEF

d = Calculated from proposed oral unit risk value

TABLE F-8
TOXICITY VALUES
SEAD-63 EE/CA
Seneca Army Depot Activity

Analyte	Oral RfD (mg/kg-day)	Inhalation RfD (mg/kg-day)	Carc. Slope Oral (mg/kg-day)-1	Rank Wt. of Evidence	Carc. Slope Inhalation (mg/kg-day)-1	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Oral Absorption Factor

e = Provisional health guideline from EPA Risk Assessment Issue Papers (1999) provided by EPA Technical Support Center
(Inhalation RfD's were derived from EPA RfC's based on the assumption of 20 m3/day inhalation rate and 70 kg body weight.)
f = Calculated from oral RFD value. (Dermal Rfd = Oral Rfd * Oral Absorption Factor)
g = Calculated from oral slope factor (Dermal Slope Factor = Oral Slope Factor/Oral Absorption Factor)
i = Provisional health guideline from EPA Risk Assessment Issue Papers (1996-1997) provided by EPA Technical Support Center
(Inhalation RfD's were derived from EPA RfC's based on the assumption of 20 m3/day inhalation rate and 70 kg body weight.)
j = Based upon EPA Human Health Evaluation Manual Supplemental Guidance: Dermal Risk Assessment Interim Guidance, 1999
k = More than 1 oral absorption factor values are available and the most conservative, i.e., the lowest value is presented.
l = Value for Aroclor-1254
m = EPA-NCEA provisional value, quoted by EPA Region III RBC Table
n = Value for Endosulfan.
o = Value for Chlordane
p = Two RfDs are available for cadmium and the most conservative is presented.
q = Values for Chromium VI.
r = For managenese, for dietary intake, a RfD of 0.14 mg/kg/day is presented in IRIS. For non-dietary intake (groundwater/soil), IRIS recommends applying a modifying factor of 3, resulting in an RfD of 0.05 mg/kg/day.
s = Value for mercuric chloride
t = Value for thallium chloride
NA = Not Available

which there will not be an appreciable risk of adverse health effects. The RfD/RfC is derived using uncertainty factors (e.g., to adjust from animals to humans and to protect sensitive subpopulations) to ensure that it is unlikely to underestimate the potential for adverse noncarcinogenic effects to occur. The purpose of the RfD/RfC is to provide a benchmark against which an intake (or an absorbed dose in the case of dermal contact) from human exposure to various environmental conditions might be compared. Intake of doses that are significantly higher that the RfD/RfC may indicate that an inadequate margin of safety could exist for exposure to that substance and that an adverse health effect could occur.

F.4.1.1 References Doses for Oral and Inhalation Exposure

The types of toxicity values used to evaluate the noncarcinogenic effects of chemicals include RfDs for oral exposure, and RfCs for inhalation exposure. RfDs and RfCs represent thresholds for toxicity. They are derived such that human lifetime exposure to a given chemical via a given route at levels at or below the RfD or RfC, as appropriate, should not result in adverse health effects, even for the most sensitive members of the population. The chronic RfD or RfC for a chemical is ideally based on studies where either animal or human populations were exposed to a given chemical by a given route of exposure for the major portion of the life span (referred to as a chronic study). Various effect levels may be determined in a study; however, the preferred effect level for calculating noncarcinogenic toxicity values is the no-observed-adverse-effect level, or NOAEL. Second to the NOAEL is the lowest-observed-adverse-effect level, or LOAEL.

The oral RfD is derived by determining dose-specific effect levels from all the available quantitative studies, and applying uncertainty factors and/or a modifying factor to the most appropriate effect level. Uncertainty factors are intended to account for 1) the variation in sensitivity among members of the human population, 2) the uncertainty in extrapolating animal data to humans, 3) the uncertainty in extrapolating from data obtained in a study that is less than lifetime exposure, 4) the uncertainty in using LOAEL data rather than NOAEL data, and 5) the uncertainty resulting from inadequacies in the data base. The modifying factor may be used to account for other uncertainties such as inadequacy of the number of animals in the critical study. Usually each of these uncertainty factors is set equal to 10, while the modifying factor varies between one and 10. RfDs are reported as doses in milligrams of chemical per kilogram body weight per day (mg/kg-day).

The inhalation RfC is derived by determining concentration-specific effect levels from all of the available literature and transforming the most appropriate concentration to a human RfC. Transformation usually entails converting the concentration and exposure duration used in the study to an equivalent continuous 24-hour exposure, transforming the exposure-adjusted value to account for differences in animal and human inhalation, and then applying uncertainty factors and/or a modifying factor to the adjusted human exposure concentration to arrive at an RfC. The uncertainty factors potentially used are the same ones used to arrive at an RfD (see above). RfCs are reported as concentrations in milligrams of chemical per cubic meter of air (mg/m^3). To use the RfCs in calculating risks, they were converted to inhalation reference doses in units of milligrams of chemical per kilogram of body weight per day (mg/kg/day). This conversion was made by assuming an inhalation rate of 20 m^3/day and an adult body weight of 70 kg. Thus:

$$\textbf{Inhalation Reference Dose (mg/kg/day)} = RfC\left(\frac{mg}{m^3}\right)x\left(\frac{20m^3}{day}\right)x\left(\frac{1}{70kg}\right)$$

F.4.1.2 Reference Doses for Dermal Exposure

At this time, chemical specific dermal toxicity factors are not available. This risk assessment evaluated risks from dermal contact with contaminants according to the most recent EPA guidance on dermal risk assessment (USEPA, 1999). The guidance provides an approach which accounts for the fact that most oral RfDs are expressed as the amount of substance administered per unit time and body weight, whereas exposure estimates for the dermal pathway are expressed as absorbed dose. Primarily, a dermal RfD was estimated from the oral RfD by adjusting for the gastrointestinal absorption efficiency. For compounds recommended by Table 4.1 of the guidance for adjustment of toxicity factors, the GI absorption efficiency values in the table were used to calculate the dermal RfD. For all other compounds, oral RfDs were used to evaluate dermal exposure risks, i.e., a GI absorption efficiency value of 1 was used. Oral absorption factors and the calculated dermal RfDs are shown in **Table F-8**.

F.4.1.3 Exposure Periods

As mentioned earlier, chronic RfDs and RfCs are intended to be set at levels such that human lifetime exposure at or below these levels should not result in adverse health effects, even for the most sensitive members of the population. These values are ideally based on chronic exposure studies in humans or animals. Chronic exposure for humans is considered to be exposure of roughly seven years or more, based on exposure of rodents for one year or more in animal toxicity studies. For day care children and construction workers, chronic RfDs and RfCs were used to conservatively assess risks for shorter exposure periods.

F.4.2 Carcinogenic Effects

For chemicals that exhibit carcinogenic effects, most authorities recognize that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This is the non-threshold theory of carcinogenesis, which purports that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. Generally, regulatory agencies assume the non-threshold hypothesis for carcinogens in the absence of information concerning the mechanisms of action for the chemical of concern.

USEPA's Carcinogen Risk Assessment Verification Endeavor (CRAVE) has developed slope factors and unit risks (i.e., dose-response values) for estimating excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. The carcinogenic slope factors can be used to estimate the lifetime excess cancer risk associated with exposure to a potential carcinogen. Risks estimated using slope factors are considered unlikely to underestimate actual risks, but they may overestimate actual risks. Excess lifetime cancer risks are generally expressed in scientific notation. An excess lifetime cancer risk of 1×10^{-6} (one in a million), for example, represents the probability of an individual developing cancer over a lifetime as a result of exposure to the specific carcinogenic chemical. USEPA considers total excess lifetime cancer risks within the range of 10^{-4} (one in ten thousand) to 10^{-6} (EPA, 1989a) to be acceptable when developing remedial alternatives for cleanup of Superfund Sites.

In practice, slope factors are derived from the results of human epidemiology studies or chronic animal bioassays. The data from animal studies are fitted to the linearized, multistage model and a dose-response curve is obtained. The upper limit of the 95th percentile confidence-interval slope of the dose-response curve is subjected to various adjustments, and an interspecies scaling factor is applied to conservatively derive the slope factor for humans. This linearized multistage procedure leads to a plausible upper limit of the risk that is consistent with some proposed mechanisms of carcinogenesis. Thus, the actual risks associated with exposure to a potential carcinogen are not likely to exceed the risks estimated using these slope factors, but they may be much lower. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad-hoc basis. These models provide rough but plausible estimates of the upper limits on lifetime risk. Slope factors based on human epidemiological data are also derived using very conservative assumptions and, as such, are considered unlikely to underestimate risks. In summary, while the actual risks associated with exposures to potential carcinogens are unlikely to be higher than the risks calculated using a slope factor, they could be considerably lower.

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. The USEPA system involves characterizing the overall weight of evidence for a chemical's carcinogenicity based on availability of animal, human, and other supportive data. The weight-of-evidence classification is an attempt to determine the likelihood that the agent is a human carcinogen, and thus qualitatively affects the estimation of potential health risks. Three major factors are considered in characterizing the overall weight of evidence for carcinogenicity: (1) the quality of evidence from human studies, (2) the quality of evidence from animal studies, which are combined into a characterization of the overall weight of evidence for human carcinogenicity; and (3) other supportive information which is assessed to determine whether the overall weight of evidence should be modified. USEPA's final classification of the overall weight of evidence includes the following five categories:

Group A - Human Carcinogen – There is sufficient evidence from epidemiological studies to support a causal association between an agent and cancer.

Group B - Probable Human Carcinogen – There is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) or that, in the absence of adequate data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C - Possible Human Carcinogen – There is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D - Not Classified – The evidence for carcinogenicity in animals is inadequate.

Group E - No Evidence of Carcinogenicity to Humans – There is no evidence for carcinogenicity in at least two adequate animal tests in different species, or in both epidemiological and animal studies.

Slope factors and unit risks are developed by the USEPA based on epidemiological or animal bioassay data for a specific route of exposure, either oral or inhalation. For some chemicals, sufficient data are available to develop route-specific slope factors for inhalation and ingestion. For chemicals with only one route-specific slope factor but for which carcinogenic effects may also occur via another route, the available slope factor may be used by the USEPA to evaluate risks associated with several potential routes of exposure (EPA, 1989b).

A number of the chemicals of potential concern have been classified as carcinogens or potential carcinogens by USEPA, and each of these has also been assigned a carcinogenicity weight-of-evidence category, as shown in **Table F-8**. These chemicals are:

Group A - Human Carcinogens

Arsenic
Benzene

Chromium VI
Nickel

Group B - Probable Human Carcinogens

Chloroform
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Carbazole
Chrysene
Dibenz(a,h)anthracene
Indeno(1,2,3-cd)pyrene
bis(2-Ethylhexyl)phthalate
DDD, 4,4'-
DDE, 4,4'-
DDT, 4,4'-
Dieldrin
Heptachlor epoxide
Chlordane
Antimony
Beryllium
Cadmium
Lead
Aroclor-1260
Pentachlorophenol

Group C - Possible Human Carcinogens

4-Methylphenol
naphthalene

All remaining chemicals of concern are either not found to have weight of evidence rankings or are Group D or E. Group D classification means that the data are insufficient to make a determination regarding carcinogenic potential while Group E compounds have been conclusively found to be non-carcinogenic. Chemicals of potential concern found at the AOCs with potential carcinogenic effects are shown in **Table F-8** along with their cancer slope factors.

F.4.2.1 Cancer Slope Factors for Oral and Inhalation Exposure

The types of toxicity values used to evaluate the carcinogenic effects of chemicals include slope factors (SFs) for oral exposure, and unit risk factors (URFs) for inhalation exposure. Oral slope factors are reported as risk per dose $(mg/kg\text{-}day)^{-1}$. Inhalation unit risk factors are reported in units of risk per concentration $(mg/m^3)^{-1}$. To make use of the unit risk factors in calculating risks they first had to be converted to inhalation slope factors in units of $(mg/kg\text{-}day)^{-1}$. This conversion was made by assuming an inhalation rate of 20 m^3/day and an adult bodyweight of 70 kg. Thus:

$$\textbf{Inhalation slope factor (mg/kg-day)}^{-1} = UnitRisk\left(\frac{ug}{m^3}\right)^{-1} \times \frac{day}{20m^3} \times 70kg \times \frac{1000ug}{mg}$$

F.4.2.2 Cancer Slope Factors for Dermal Exposure

As discussed above, USEPA has not derived toxicity values for the dermal route of exposure. In the absence of dermal reference toxicity values, USEPA has suggested (EPA, 1999) that it is appropriate to modify an oral slope factor so it can be used to estimate the risk incurred by dermal exposure. The oral slope factors were converted to dermal slope factors by dividing by the oral absorption efficiency recommended by EPA. The same values presented in Section 5.4.1.2 were used, however, if chemical specific modification factors were unavailable, oral values were used without adjustment.

F.4.2.3 Toxic Equivalency Factors

When slope factors and unit risks were not available for all potentially carcinogenic members of a chemical class, toxicity values were calculated using toxicity equivalency factors (TEFs). TEFs are values that compare the carcinogenic potential of a given chemical in a class to the carcinogenic potential of a chemical in the class that has a verified slope factor and/or unit risk. USEPA has provided TEFs for PAHs (EPA, 1993b). TEF values are as follows:

PAH	TEF
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Dibenzo(a,h)anthracene	1.0
Chrysene	0.001

Indeno(1,2,3-cd)pyrene	0.1

To calculate a slope factor or unit risk for a given PAH the appropriate TEF value is multiplied by the slope factor or unit risk for benzo(a)pyrene.

F.5 Risk Characterization

F.5.1 Introduction

To characterize risk, toxicity and exposure assessments were summarized and integrated into quantitative and qualitative expressions of risk. To characterize potential noncarcinogenic effects, comparisons were made between projected intakes of substances and toxicity values. To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes and chemical-specific dose-response information. Major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties embodied in the assessment are also presented.

F.5.1.1 Noncarcinogenic Effects

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period with an RfD derived for a similar exposure period. This ratio of exposure to toxicity is called a hazard quotient according to the following equation:

Noncancer Hazard Quotient = E/RfD

Where:

E = Exposure level or intake (mg/kg-day), and
RfD = Reference Dose (mg/kg-day)

The noncancer hazard quotient assumes that there is a level of exposure (i.e., an RfD) below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure level (E) exceeds the threshold (i.e., If E/RfD exceeds unity) there may be concern for potential noncancer effects.

To assess the overall potential for noncarcinogenic effects posed by more than one chemical, a hazard index (HI) approach has been developed by the USEPA. This approach assumes that simultaneous sub-threshold exposures to several chemicals could result in an adverse health effect. It also assumes that the magnitude of the adverse effect will be proportional to the sum of the ratios of the subthreshold exposures to respective acceptable exposures.

This is expressed as:

$$HI = E_1/RfD_1 + E_2/RfD_2 + ... + E_i/RfD_i$$

Where:

E_i = the exposure level or intake of the I toxicant, and
RfD_i = reference dose for the i^{th} toxicant.

While any single chemical with an exposure level greater than the toxicity value will cause the HI to exceed unity, for multiple chemical exposures, the HI can also exceed unity even if no single chemical exposure exceeds its RfD. The assumption of dose additivity reflected in the HI is best applied to compounds that induce the same effects by the same mechanisms. Applying the HI to cases where the known compounds do not induce the same effect may overestimate the potential for effects. To assess the overall potential for noncarcinogenic effects posed by several exposure pathways, the total HI for chronic exposure is the sum of the HI's for each pathway, for each receptor.

F.5.1.2 Carcinogenic Effects

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen (i.e., excess individual lifetime cancer risk). The slope factor converts estimated daily intakes averaged over a lifetime of exposure directly to incremental risk of an individual developing cancer. It can generally be assumed that the dose-response relationship will be linear in the low-dose portion of the multistage model dose-response curve. Under this assumption, the slope factor is a constant, and risk will be directly related to intake. Thus, the following linear low-dose equation was used in this assessment:

$$Risk = CDI \times SF$$

Where:

Risk = A unitless probability of an individual developing cancer,
CDI = Chronic Daily Intake over 70 years (mg/kg-day), and
SF = Slope Factor $(mg/kg\text{-}day)^{-1}$

Because the slope factor is often an upper 95th-percentile confidence limit of the probability of a response and is based on animal data used in the multistage model, the carcinogenic risk will generally be an upper-bound estimate. This means that the "true risk" is not likely to exceed the risk estimate derived through this model and is likely to be less than predicted.

For simultaneous exposure to several carcinogens. the USEPA assumes that the risks are additive. That is to say:

$$\mathbf{Risk_T = Risk1 + Risk2 + ... + Risk_i}$$

Where:

$Risk_T$ = Total cancer risk. expressed as a unitless probability. and
$Risk_i$ = Risk estimate for the ith substance.

Addition of the carcinogenic risks is valid when the following assumptions are met:

- doses are low,
- no synergistic or antagonistic interactions occur. and
- similar endpoints are evaluated.

According to guidance in the National Contingency Plan. the target overall lifetime carcinogenic risks from exposures for determining clean-up levels should range from 10^{-4} to 10^{-6}.

F.5.2 Risk Summary

Human health risks were calculated for three future exposure scenarios at SEAD-63. The receptors and exposure scenarios were based on the expected future land use for SEAD-63. which is as a conservation and recreation area. The potential exposure pathways associated with each receptor are summarized in **Figure 2-12** in **Section 2** of **Appendix A.**

The potential exposure routes associated with each exposure scenario are as follows:

Park worker: Inhalation of ambient air. ingestion of soil. dermal contact with soil. ingestion of groundwater. dermal contact with ditch water. and dermal contact with ditch sediment.

Construction worker: Inhalation of ambient air. ingestion of soil. and dermal contact with soil.

Recreational visitor (child): Inhalation of ambient air. ingestion of soil. dermal contact with soil. ingestion of groundwater. dermal contact with groundwater while showering. dermal contact with ditch water. and dermal contact with ditch sediment.

In addition, inhalation of ambient air, ingestion of soil, dermal contact with soil, ingestion of groundwater, dermal contact with groundwater while showering, dermal contact with ditch water, and dermal contact with ditch sediment were evaluated for residential receptors for comparative purposes only. Future residential use of the site is highly unlikely.

Cancer and non-cancer risks at SEAD-63 were calculated for all applicable exposure routes and are presented in **Table F-9**. The table also serves as a guide to the tables in **Attachment A** that show risk calculations for each exposure route. The USEPA defined targets for lifetime cancer risk range from 10^{-4} to 10^{-6}; the non-cancer hazard index is less than one. The total cancer risk for the Park worker (5E-05), the Construction worker (9E-08), and the recreational visitor (child) (8E-05) is within the USEPA target risk range. The total non-cancer hazard index from all

TABLE F-9
CALCULATION OF TOTAL NONCARCINOGENIC AND CARCINOGENIC RISKS
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
Engineering Evaluation/Cost Analysis
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	EXPOSURE/RISK CALCULATIONS Table Number	HAZARD INDEX	CANCER RISK
PARK WORKER	Inhalation of Dust in Ambient Air	Table A-1	7E-07	1E-09
	Ingestion of Soil	Table A-4	1E-03	5E-08
	Dermal Contact to Soil	Table A-6	4E-04	8E-08
	Ingestion of Groundwater	Table A-9	1E-01	NQ
	Dermal Contact to Surface Water	Table A-13	4E-03	5E-05
	Dermal Contact to Sediment	Table A-14	1E-03	1E-06
	TOTAL RECEPTOR RISK (Nc & Car)		**2E-01**	**5E-05**
RECREATIONAL VISITOR (CHILD)	Inhalation of Dust Ambient Air	Table A-1	1E-06	5E-10
	Ingestion of Soil	Table A-4	4E-03	4E-08
	Dermal Contact to Soil	Table A-6	4E-04	2E-08
	Ingestion of Groundwater	Table A-8	3E-01	NQ
	Dermal Contact to Groundwater	Table A-11	5E-02	NQ
	Dermal Contact to Surface Water	Table A-13	4E-02	8E-05
	Dermal Contact to Sediment	Table A-15	1E-02	3E-06
	TOTAL RECEPTOR RISK (Nc & Car)		**4E-01**	**8E-05**
CONSTRUCTION WORKER	Inhalation of Dust in Ambient Air	Table A-1	9E-05	3E-08
	Ingestion of Soil	Table A-4	2E-01	4E-08
	Dermal Contact to Soil	Table A-6	2E-02	1E-08
	TOTAL RECEPTOR RISK (Nc & Car)		**3E-01**	**9E-08**
ADULT RESIDENT (Hazard Index)	Inhalation of Dust Ambient Air	Table A-2	3E-06	See risk below
	Ingestion of Soil	Table A-5	2E-03	
	Dermal Contact to Soil	Table A-7	3E-04	
	Ingestion of Groundwater	Table A-9	6E-01	
	Dermal Contact to Groundwater	Table A-12	1E-01	
	Dermal Contact to Surface Water	Table A-14	5E-03	
	Dermal Contact to Sediment	Table A-16	1E-03	
	TOTAL RECEPTOR RISK (Nc & Car)		**7E-01**	
CHILD RESIDENT (Hazard Index)	Inhalation of Dust Ambient Air	Table A-2	7E-06	See risk below
	Ingestion of Soil	Table A-5	2E-02	
	Dermal Contact to Soil	Table A-7	2E-03	
	Ingestion of Groundwater	Table A-9	1E+00	
	Dermal Contact to Groundwater	Table A-12	2E-01	
	Dermal Contact to Surface Water	Table A-14	4E-02	
	Dermal Contact to Sediment	Table A-15	1E-02	
	TOTAL RECEPTOR RISK (Nc & Car)		**2E+00**	
RESIDENT (Total Lifetime Cancer Risk)	Inhalation of Dust Ambient Air	Table A-2	See risk above	8E-09
	Ingestion of Soil	Table A-5		3E-07
	Dermal Contact to Soil	Table A-7		1E-08
	Ingestion of Groundwater	Table A-9		NQ
	Dermal Contact to Groundwater	Table A-12		NQ
	Dermal Contact to Surface Water	Table A-14		1E-04
	Dermal Contact to Sediment	Table A-16		4E-06
	TOTAL RECEPTOR RISK (Nc & Car)			**1E-04**

NQ = Not Quantified due to lack of toxicity data
Non-cancer risk is reported for adults and child residents separately. Cancer risk is considered over a lifetime, therefore the adult and child values are summed

exposure routes is less than one for the Park worker. Construction worker. and Recreational visitor (child). The total non-cancer hazard index for a child resident and the lifetime cancer risk for a resident slightly exceed USEPA target risk range (non-cancer hazard index of 2 for the child and cancer risk of 1E-4 for the resident). The total non-cancer hazard index for an adult resident is 0.7. which is within the USEPA target risk range.

The driven risks for recreational visitor (child) and resident receptors are exposure to benzo(a)pyrene and dibenz(a.h)anthracene in surface water. These two constituents were only detected in one out of 22 samples. In addition. the ditch at the site is usually dry except during storm period. The vegetation observed in the ditches. i.e.. cattail. verifies this conclusion since cattails prefer saturated soil conditions to flooded conditions. Therefore, risks driven by these two constituents are most likely significantly lower than indicated by the mini-risk assessment.

F.5.3 Risk Characterization for Lead

Lead was not detected above background levels in soil or groundwater. Therefore. lead is not a compound of concern.

F.5.4 Uncertainty Assessment

All risk assessments involve the use of assumptions. judgements. and imperfect data to varying degrees. This results in uncertainty in the final estimates of risk. There are uncertainties associated with each component of the risk assessment from data collection through risk characterization. For example. there is uncertainty in the initial selection of substances used to characterize exposures and risk on the basis of the sampling data and available toxicity information. Other sources of uncertainty are inherent in the toxicity values for each substance and the exposure assessments used to characterize risk. Finally. additional uncertainties are incorporated into the risk assessment when exposures to several substances across multiple pathways are summed. Areas of uncertainty in each risk assessment step are discussed below.

F.5.4.1 Uncertainty in Data Collection and Evaluation

Uncertainties in the data collection/evaluation step of the risk assessment focus on determining whether enough samples were collected to adequately characterize the risk. and if sample analyses were conducted in a qualified manner to maximize the confidence in the results. Results of the sample analyses were used to develop a database, which includes a complete list of the chemicals. by media and their representative concentrations used in the risk assessment. The sampling and analysis addressed various objectives in addition to the risk assessment. Therefore. the samples were not collected randomly but were collected from areas of the site with the greatest likelihood to be contaminated. This type of non-random sampling biases the data collected toward overestimating chemical concentrations from the site.

All chemicals detected that were potentially site-related were retained in this assessment. Chemicals that were never detected were eliminated from the assessment. This practice may slightly underestimate risks due to low levels (i.e., below the sample quantitation limit) of eliminated chemicals. Since samples were collected at areas where concentrations were expected to be high and the maximum concentrations were used for the assessment, it is very unlikely that any chemicals were present at the site at health-significant levels and not detected in at least one sample. However, if this did occur, this assumption will underestimate risk. The maximum concentrations were used to calculate site-related risks. Since that assumption implies chronic exposure to the maximum concentration, this assumption is likely to overestimate risk.

F.5.4.2 Uncertainty in Exposure Assessment

There are inherent uncertainties in predicting future land uses and future chemical concentrations. Future land use scenarios were based on current plans to develop this portion of SEDA into a recreation and conservation area.

A large part of the risk assessment is the estimation of risks for a broad set of exposure scenarios and pathways. If exposure does not occur, no risks are present. This assessment does not factor in the probability of the exposure occurring. For certain pathways, exposure may be extremely unlikely. For example, the future receptors are assumed to drink groundwater. It is unlikely that this will occur, since the aquifer beneath the site is not believed to be productive enough to supply a continuous source of potable water. This assumption yields an overestimate of risk for this scenario.

Once pathways are identified, exposure point concentrations must be estimated. There is always some doubt as to how well an exposure model approximates the actual conditions receptors will be exposed to at a given site. Key assumptions in estimating exposure point concentrations and exposure assumptions and their potential impact on the assessment are described in the following paragraphs.

As summarized in **Table F-9**, there are many factors that determine the level of exposure for each exposure pathway. These factors include inhalation rates, ingestion rates, exposure frequencies, exposure durations, body weight, etc. The values for these exposure factors must be selected by the risk assessor to represent each receptor. For the scenarios in this risk assessment, upper bound values were selected for each exposure factor. In the calculations of exposure, these multiple upper-bound exposure factor estimates compound to yield intakes and absorbed doses that overestimate likely exposure levels.

The EPCs (i.e., maximum concentrations) derived from the measured chemical concentrations are assumed to persist without change for the entire duration of each exposure scenario. It is likely that some degradation would occur over time, particularly for some of the organic compounds, which would reduce the current concentrations. Therefore, this steady state assumption tends to overestimate exposure levels.

F.5.4.3 Uncertainty in Toxicity Assessment

Of the chemicals of potential concern, a number had no reference dose or slope factors. They are:

- dibenzofuran
- phenanthrene
- calcium
- lead
- magnesium
- potassium
- sodium

Several of these compounds have toxicity information such as weight of evidence classification indicating a strong potential for adverse health effects, particularly lead. The absence of toxicity values for these chemicals tends to underestimate risks.

There is considerable uncertainty inherent in the toxicity values for both carcinogens and noncarcinogens. Many of the studies are based on animals and extrapolated to humans, and in some cases, subchronic studies must be used to assess chronic effects. Most cancer slope factors are calculated using a model that extrapolates low dose effects from high dose animal studies. Because toxicity constants are generally based on the upper limit of the 95th-percentile confidence interval or incorporate safety factors to compensate for uncertainty, chemical-specific risks may be overestimated.

For dermal exposure, a default dermal absorption factor of 0.1 was used for semivolatile organic compounds, and therefore led to the uncertainty of risks associated with dermal exposure. Oral toxicity values were used to evaluate risks associated with dermal exposure by adjusting gastrointestinal absorption efficiency recommended by USEPA (1999). EPA recommends a 100% gastrointestinal absorption efficiency value for chemicals not listed in Table 4.1 of the Dermal Risk Assessment Interim Guidance (USEPA, 1999). This assumption may contribute to an underestimate of risks for compounds that are actually poorly absorbed. In addition, dermal contact with a chemical may also result in direct dermal toxicity, such as allergic contact dermatitis, urticarial reactions, chemical irritations, and skin cancer, which was not evaluated using the USEPA's recommended approach. Therefore, dermal risks evaluated in the report does not address potential dermal toxicity associated with direct contact.

F.5.4.4 Uncertainty in Risk Characterization

Uncertainties in the toxicity assessment are compounded under the assumption of dose additivity for multiple substance exposure. That assumption ignores possible synergisms and antagonisms among chemicals, and assumes similarity in mechanisms of action and metabolism. Overall, these assumptions would tend to overestimate risk. Similarly, risks summed for chemicals having various weight-of-evidence classifications as well as different target organs may also tend to overestimate risk.

F.6 Ecological Risk Assessment (ERA)

F.6.1 Objectives and Overview

In addition to the evaluation of human health, this mini-risk assessment considers the risk posed by the site to its ecological communities. This ecological risk assessment (ERA) is intended to indicate the potential, if any, of chemicals found at the site to pose a risk or stress to plants or animals that may inhabit or visit the land proposed to be developed into a conservation and recreation area.

An ecological field survey specific to SEAD-63 has not been performed. However, other areas of SEDA have been studied to characterize the ecological communities at SEDA in general and at specific SEADs (e.g. SEADs 16, 17, 25 and 26). Field surveys during the Remedial Investigations of these SEADs produced an understanding of the habitat, vegetative communities and wildlife species present at the site. Since the land at SEAD-63 is environmentally similar to the other areas at SEDA studied in depth, the existing ecological characterizations are considered to apply as well to SEAD-63, and this mini-ERA is based upon the findings of these prior field surveys.

As preceding sections of this report have indicated, the existing SEAD-63-specific database of chemical and physical information was developed to characterize the types, locations, and concentrations of chemicals in soil, groundwater, surface water and sediment. Calculations in this mini-ERA are conservatively based on the maximum concentrations of each chemical detected in each medium of potential concern to ecological receptors (soil for SEAD-63).

The ERA addresses potential risks to the following biological groups and special-interest resources associated with the site: vascular vegetation, wildlife, aquatic life, endangered and threatened species, and wetlands. The focus of the ERA lies in the evaluation of the potential toxicity of each constituent of potential concern (COPC) in soil and defines toxicity benchmark values that will be used to calculate the ecological risk quotient.

The purpose of the ERA is to evaluate the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to chemicals associated with the site based on a weight-of-evidence approach. An ecological risk does not exist unless a given contaminant has the ability to cause one or more adverse effects and it is contacted by, an ecological receptor for a sufficient length of time, or at a sufficient intensity to elicit the identified adverse effect(s) (EPA, 1994b).

In this ERA, ecological receptors were determined based on prior studies at SEDA. Impacts from exposure to these receptors are determined using conservative assumptions to assure that a reasonable degree of protection is maintained. Ecological risk is then presented in terms of a hazard quotient (HQ), which is defined as the ratio of the estimated exposure point concentration to an appropriate toxicity reference value (TRV). Separate HQs are calculated for each contaminant/receptor pair and are summed, if appropriate, to derive a site-wide hazard index (HI). Uncertainties are the greatest and arise from extrapolation of the available toxicity data and inference regarding exposure. In general, ratios of exposure point concentration to TRV greater than 1 are considered to indicate a potential risk. Due to the uncertainties associated with using this approach, safety factors are considered in interpreting the findings. HQs between 1 and 10 are interpreted as having some potential for adverse effects; whereas, HQs between 10 and 100 indicate a significant potential for adverse effects. HQs greater than 100 indicate that adverse effects can be expected.

F.6.2 **Problem Formulation**

Problem formulation establishes the goals, breadth, and focus of the ERA through the following:

- Identification of the ecological COPCs
- Characterization of ecological communities
- Selection of assessment endpoints
- Presentation of an ecological conceptual site model
- Selection of an analysis plan (including measures of effects).

Each of these steps is described in the following sections.

F.6.2.1 Identification of Ecological Constituents of Potential Concern

Samples of four environmental media, soil, groundwater, surface water, and sediment were collected during the investigations of SEAD-63. However, only the chemicals detected found in soil and sediment have been evaluated to determine their potential effect on the ecological community. Chemicals detected in the groundwater have not been considered because there is no indication of a direct link between the selected ecological receptors and the groundwater. The effects of chemicals detected in surface water have also not been evaluated because the surface water bodies found at SEAD-63 are highly intermittent in nature, resulting only from storm run-off events, and are identified as incapable of supporting ecological communities.

The potential effects of chemicals found in shallow (i.e., collected at sample depths of less than 2 feet below grade) soil and sediment samples have been assessed by combining the two datasets into a single composite dataset. **Table F-1** presents a summary of the combined dataset. The maximum concentration of any chemical, other than metals where a preliminary screening of the combined dataset against the existing background dataset was completed, was then considered as constituents of potential concern (COPCs) for the ERA. The results of the screening of metals found in SEAD-63 shallow soil and sediments versus site background soils are presented in **Table F-4**.

The highest concentration for each remaining COPC measured at the site was used as the exposure point concentration (EPC) in the calculations presented later in this section.

F.6.2.2 Site Habitat Characterization

Characterizations of site habitat and ecological communities developed as part of the RIs for SEADs-16, 17, 25 and 26 and the Open Burning (OB) Grounds were assumed to be representative of SEAD-63 discussed in this mini-ERA. Key aspects of these characterizations relevant to this mini-risk assessment are presented here.

Ecological site characterizations were based on compilation of existing ecological information and on-site reconnaissance activities. The methods used to characterize the ecological resources included site walkovers for the evaluation of existing wildlife and vegetative communities; interviews with local, state, and SEDA resource personnel; and review of environmental data obtained from previous Army reports. SEDA has a strong wildlife management program that is reviewed and approved by the New York Fish and Game Agency. The depot manages an annual white-tailed deer (Odocoileus virginiana) harvest and has constructed a large wetland called the "duck pond" in the northeastern portion of the facility to provide a habitat for migrating unts e [illegible] timate the hard size at approximately 600 animals, between ted eac [illegible] fall.

tage Pr [illegible] ogram Biological and Conservation Data System identifies no eral- o [illegible] state-designated threatened or endangered plant or animal ius of t [illegible] he site. No species of special concern are documented within

dlife R [illegible] esources and Resources Used by Humans

trial re [illegible] source known to occur at SEDA is the population of white- Ddocoi [illegible] eus virginiana), which inhabits the fenced Depot. Annual deer ate the [illegible] herd size is approximately 600 animals, approximately one- ged. S [illegible] ince the depot is totally enclosed, the white-pelaged deer is of inb [illegible] eeding within the herd. To prevent overgrazing and starvation tains t [illegible] he herd through an annual hunting season on the depot. The ducts t [illegible] he management plan of the herd. The normal brown-pelaged ite-tail [illegible] d deer are not listed as a rare or endangered species.

agric [illegible] ltural crops and deciduous forests comprise the vegetative s. Al [illegible] hough no crops are grown on the Depot, farmland is the e surro [illegible] unding private lands. Crops including corn, wheat, oats, beans n prim [illegible] arily for livestock feed. Deciduous forestland on the depot and is un [illegible] der active forest management. Timber and firewood are dlots. [illegible] o timber harvesting occurs on the Depot.

ere are [illegible] several wildlife species that are hunted and trapped on private ted in [illegible] lude the eastern cottontail, white-tailed deer, ruffed grouse, arious [illegible] waterfowl. Gray squirrel and wild turkey are hunted to a lesser es trap [illegible] ped in this study area include red and gray fox and raccoon. trapped [illegible] to a lesser extent (Woodruff 1992). On the Depot, deer, huntin [illegible] g is allowed, although the designated waterfowl hunting area is pping [illegible] s also permitted (SEDA 1992).

l game [illegible] mammals in the installation include eastern cottontail and gray oe har [illegible] e, muskrat, beaver, eastern coyote, red fox, and gray fox. n Rob [illegible] n, Ruffed grouse, ring-necked pheasant, and wild turkey also owl are [illegible] attracted to wetlands on and around the depot, particularly the

87-acre "duck ponds" created in the northeast corner of the property during the 1970s. Many non-game species also are present in the depot and potentially utilize available habitat.

F.6.2.3 Ecological Assessment Endpoint(s)

EPA's draft Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA, 1994b) states that the selection of assessment endpoints depends on the following:

1. The constituents present and their concentrations.
2. Mechanisms of toxicity to different groups of organisms.
3. Potential species present, and
4. Potential complete exposure pathways.

The constituents and concentrations are discussed in detail in **Section F.2.** Mechanisms of toxicity are evaluated conceptually in the analysis plan in **Section F.6.2.4.** Potential species present were discussed in **Section F.6.2.2.** Potential complete exposure pathways and receptor selection are described below.

To assess whether adverse ecological effects have occurred or may occur at the site as a result of ecological receptors' exposure to COPCs, ecological endpoints were selected. An ecological endpoint is a characteristic of an ecological component that may be affected by exposure to a stressor, such as a chemical. Assessment endpoints represent environmental values to be protected and generally refer to characteristics of populations and ecosystems (EPA, 1994b). Unlike the human health risk assessment process, which focuses on individual receptors, the ERA focuses on populations or groups of interbreeding non-human, non-domesticated receptors. In the ERA process, risks to individuals are assessed only if they are protected under the Endangered Species Act, as well as species that are candidates for protection or are considered rare.

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Therefore, EPA, in the *Proposed Guidelines for Ecological Risk Assessment* (EPA, 1996a) has suggested three criteria that should be considered in selecting assessment endpoints suitable for a specific ecological risk assessment. These criteria are: ecological relevance, susceptibility to the contaminant(s), and representation of management goals.

- Ecological relevance. The assessment endpoint should have biological/ecological significance to a higher level of the ecological hierarchy. Relevant endpoints help sustain the natural structure, function, and biodiversity of an ecosystem. For example, an increase in mortality or a decrease in fecundity of individuals is ecologically significant if it affects the size or productivity of the population. Likewise, a decrease in the size of a population is ecologically significant if it affects the number of species, the productivity, or some other property of the ecosystem.

- Susceptibility to the contaminant(s). The assessment endpoint should be susceptible to exposure to the contaminant(s) and should be responsive/sensitive to such exposure. That is, assessment endpoints should be chosen that are likely to be exposed to contaminants at the site, either directly or indirectly (e.g., through the food chain), and they should be sensitive enough that such exposure may elicit an adverse response. Ideally, this sensitivity should be at such a level that other site-related receptors of potential concern are adequately protected under the selected endpoint's response threshold.

- Representation of management goals. The value of a risk assessment depends on whether it can support quality management decisions. Therefore the assessment is based on values and organisms that reflect management goals. The protection of ecological resources (e.g., habitats and species of plants and animals) is a principal motivation for conducting ERAs. Key aspects of ecological protection are presented as policy goals, which are general goals established by legislation or agency policy based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies (e.g., CERCLA, National Environmental Policy Act). Other legislation includes the Endangered Species Act, 16 U.S.C. 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act, 16 U.S.C. 703-711 (1993, as amended). **Table F-10** shows the policy goals established for the site. To determine whether these protection goals are met at the site, assessment and measurement endpoints are formulated that define the specific ecological values to be protected and the degree to which each may be protected.

The Depot does not provide habitat for any threatened or endangered species; therefore, the assessment endpoint of no reduction in numbers of any threatened/endangered species is met. However, the available field surveys indicate that the site is likely to be used by mammal populations. Accordingly, the assessment endpoint that has been selected to represent the policy

F.6.2.1 Identification of Ecological Constituents of Potential Concern

Samples of four environmental media, soil, groundwater, surface water, and sediment were collected during the investigations of SEAD-63. However, only the chemicals detected found in soil and sediment have been evaluated to determine their potential effect on the ecological community. Chemicals detected in the groundwater have not been considered because there is no indication of a direct link between the selected ecological receptors and the groundwater. The effects of chemicals detected in surface water have also not been evaluated because the surface water bodies found at SEAD-63 are highly intermittent in nature, resulting only from storm run-off events, and are identified as incapable of supporting ecological communities.

The potential effects of chemicals found in shallow (i.e., collected at sample depths of less than 2 feet below grade) soil and sediment samples have been assessed by combining the two datasets into a single composite dataset. **Table F-1** presents a summary of the combined dataset. The maximum concentration of any chemical, other than metals where a preliminary screening of the combined dataset against the existing background dataset was completed, was then considered as constituents of potential concern (COPCs) for the ERA. The results of the screening of metals found in SEAD-63 shallow soil and sediments versus site background soils are presented in **Table F-4**.

The highest concentration for each remaining COPC measured at the site was used as the exposure point concentration (EPC) in the calculations presented later in this section.

F.6.2.2 Site Habitat Characterization

Characterizations of site habitat and ecological communities developed as part of the RIs for SEADs-16, 17, 25 and 26 and the Open Burning (OB) Grounds were assumed to be representative of SEAD-63 discussed in this mini-ERA. Key aspects of these characterizations relevant to this mini-risk assessment are presented here.

Ecological site characterizations were based on compilation of existing ecological information and on-site reconnaissance activities. The methods used to characterize the ecological resources included site walkovers for the evaluation of existing wildlife and vegetative communities; interviews with local, state, and SEDA resource personnel; and review of environmental data obtained from previous Army reports. SEDA has a strong wildlife management program that is reviewed and approved by the New York Fish and Game Agency. The depot manages an annual white-tailed deer (Odocoileus virginiana) harvest and has constructed a large wetland called the "duck pond" in the northeastern portion of the facility to provide a habitat for migrating waterfowl. Winter deer counts estimate the hard size at approximately 600 animals, between 250-300 animals are harvested each fall.

The NYSDEC Natural Heritage Program Biological and Conservation Data System identifies no known occurrences of federal- or state-designated threatened or endangered plant or animal species within a 2-mile radius of the site. No species of special concern are documented within the depot property.

Significant Terrestrial Wildlife Resources and Resources Used by Humans

The only significant terrestrial resource known to occur at SEDA is the population of white-pelaged white-tailed deer (Odocoileus virginiana), which inhabits the fenced Depot. Annual deer counting at the depot indicate the herd size is approximately 600 animals, approximately one-third (200) are white-pelaged. Since the depot is totally enclosed, the white-pelaged deer is thought to occur as a result of inbreeding within the herd. To prevent overgrazing and starvation of the deer, the depot maintains the herd through an annual hunting season on the depot. The New York State DFW conducts the management plan of the herd. The normal brown-pelaged deer are also common. White-tailed deer are not listed as a rare or endangered species.

In the vicinity of SEDA, agricultural crops and deciduous forests comprise the vegetative resources used by humans. Although no crops are grown on the Depot, farmland is the predominant land use in the surrounding private lands. Crops including corn, wheat, oats, beans and hay mixtures, are grown primarily for livestock feed. Deciduous forestland on the depot and surrounding private lands is under active forest management. Timber and firewood are harvested from private woodlots. No timber harvesting occurs on the Depot.

In the vicinity of SEDA, there are several wildlife species that are hunted and trapped on private lands. Game species hunted include the eastern cottontail, white-tailed deer, ruffed grouse, ring-necked pheasant and various waterfowl. Gray squirrel and wild turkey are hunted to a lesser extent. Fur-bearing species trapped in this study area include red and gray fox and raccoon. Muskrat and beaver are trapped to a lesser extent (Woodruff 1992). On the Depot, deer, waterfowl and small game hunting is allowed, although the designated waterfowl hunting area is outside the study area. Trapping is also permitted (SEDA 1992).

Commonly occurring small game mammals in the installation include eastern cottontail and gray squirrel, raccoon, snowshoe hare, muskrat, beaver, eastern coyote, red fox, and gray fox. Mourning doves, American Robin, Ruffed grouse, ring-necked pheasant, and wild turkey also inhabit the depot. Waterfowl are attracted to wetlands on and around the depot, particularly the

TABLE F-10
POLICY GOALS, ECOLOGICAL ASSESSMENT AND MEASUREMENT ENDPOINTS, AND DECISION RULES
SEAD-63 EE/CA
Seneca Army Depot Activity

Policy Goals	Assessment Endpoint	Measurement Endpoint	Decision Rule
Policy Goal 1: The conservation of threatened and endangered species (TES) and their critical habitats	**Assessment Endpoint 1:** No reduction in numbers of any state- or federally-designated TES	**Measurement Endpoint 1:** Biosurveys for TES plants and animals; COPC concentration in physical media and predicted concentration in prey species	**Decision Rule for Assessment Endpoint** 1: If TES are not present, or COPC Maximum concentrations in the media do not exceed toxicity screening thresholds or dietary NOAELS (i.e., HQ<1), the assessment endpoint is met and TES are not at risk
Policy Goal 2: The protection of terrestrial populations and ecosystems	**Assessment Endpoint 2:** No substantial adverse effect on populations of small mammals (i.e., deer mouse)	**Measurement Endpoint 2:** Lowest chronic, dietary, non-lethal effect level of COPCs on mice	**Decision Rule for Assessment Endpoint** 2: If ratios of estimated exposure concentrations predicted from COPC Maximum concentrations in soil to dietary limits corresponding to LOAEL toxicity reference values for adverse effects on deer mice (HQs) are <1, th

COPC = constituent of potential concern.
TES = threatened and endangered species.
NOAEL = no observed adverse effect level.
LOAEL = lowest observed adverse effect level.
HQ = hazard quotient.

goal of protection of terrestrial populations and ecosystems is "no substantial adverse effect on survival, growth, and reproduction of resident mouse populations."

Surface water as it exists intermittently in drainage ditches at the site does not directly support aquatic life. Sediment sampled from the drainage ditches is more similar to soil than sediment associated with a surface water body (e.g., river or lake), from an ecological exposure standpoint. Therefore, these media do not pose an ecological risk to aquatic life. Exposure to chemicals found in surface water was not quantitatively assessed for potential impacts to terrestrial receptors. As is discussed above in **Section F6.2**, exposure to chemicals found in site sediments was assessed by combining the SEAD-63 sediment and shallow soil datasets.

Receptor Selection

Site-specific receptors were selected to represent assessment endpoints based principally on their importance in the community food web; their susceptibility (through exposure and sensitivity) to the site-related constituents, the amount of available data describing their potential for exposure and the toxicological effects that may result from exposure; and the extent to which they represent management goals. The native mouse species inhabiting areas of SEDA are the most appropriate receptor species for soil, and the relevant assessment endpoint was defined as "no substantial adverse effect on resident mouse populations." Given the predominately herbaceous nature of the site, the deer mouse (*Peromyscus maniculatus*) was selected as the species with the niche best met by conditions present at the site. These are the vertebrate receptors most likely to be maximally exposed to contaminants in soil at the site. They also represent a significant component of the food chain, feeding on seeds and berries and soil invertebrates and providing prey for predators. Therefore, the deer mouse was selected as the receptor species at this site and measures of effects (measurement endpoints) were selected that could be extrapolated to predict effects on the assessment endpoints. Databases and available literature were searched for toxicity data for deer mice or other native rodent species. In the absence of site-specific data, laboratory-derived data on mortality or reproductive effects were used as measurement endpoints. In the absence of data on native species, data for laboratory rodents such as laboratory mice (*Mus musculus*) and laboratory rats (*Rattus norvegicus*) were used.

A second terrestrial receptor, the short-tail shrew, was also evaluated. The shrew was selected because more of its diet is derived from soil invertebrates than the deer mouse. Therefore, the shrew may be more susceptible than the mouse to the effects of COPCs that bioaccumulate in soil biota. The shrew is a more conservative receptor than the mouse for COPCs that may bioaccumulate.

A raptor, such as a red-tailed hawk, was initially considered as a potential receptor for this ERA. However, the home range of a hawk, approximately 1800 acres or more (USEPA 1993, Wildlife Exposure Factors Handbook), is much greater than the area of the site considered in this assessment. SEAD-63 is approximately 4 acres in area. Therefore, it is unlikely that a hawk would derive a significant portion of its diet from prey at the site. As a result, the raptor was not further evaluated in this ERA.

In order to further evaluate the potential effects of contaminants uptaken by plants, a seed eating species was selected. The mourning dove, a granivorous bird, was selected. It was assumed that the majority of the doves diet consists of plant matter with minor contributions from surface soil and animal matter. The dove was considered to be representative of the maximum exposure for seed-eating birds.

A second bird receptor, the American robin, was also evaluated. The American robin was selected because a larger portion of its diet is derived from soil invertebrates than the mourning dove. Therefore, the robin may be more susceptible than the dove to the effects of COPCs that bioaccumulate in soil biota. The robin is a more conservative receptor than the mouse for COPCs that may bioaccumulate.

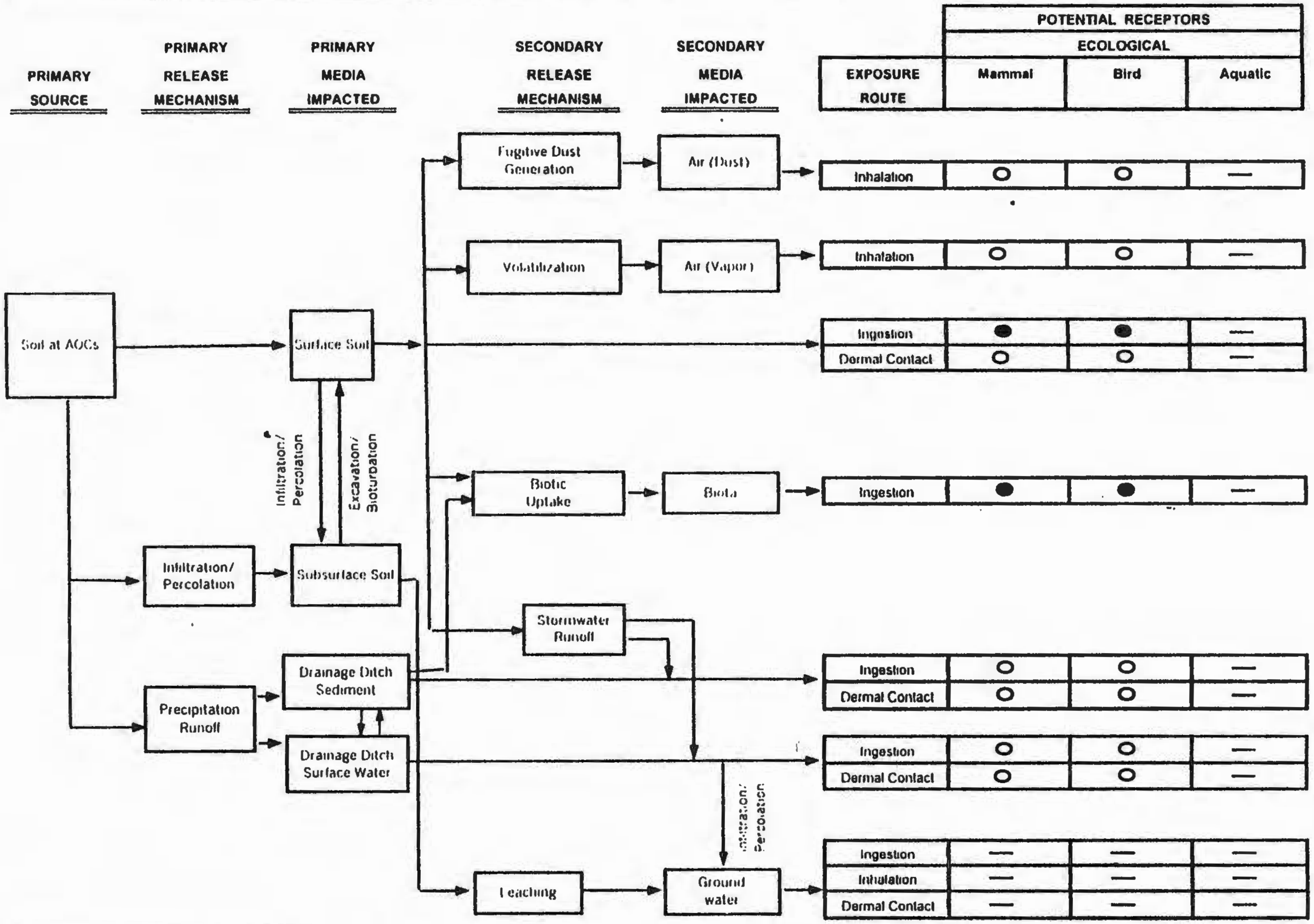
Ecological Conceptual Site Model

The conceptual site model (CSM) presents the ecological receptors at the site that are potentially exposed to hazardous substances in soil across several pathways (**Figure F-2**). A complete exposure pathway consists of the following four elements:

- A source and mechanism of contaminant release to the environment
- An environmental transport mechanism for the released contaminants
- A point of contact with the contaminated medium
- A route of contaminant entry into the receptor at the exposure point.

If any of these elements is missing, the pathway is incomplete and is not considered further in the ERA. A pathway is complete when all four elements are present and permit potential exposure of a receptor to a source of contamination. Quantification of some potentially complete pathways may not be warranted because of minimal risk contribution relative to other major pathways. The dominant pathways from sources and exposure media through the food web to ecological receptors potentially exposed to ecological COPCs at the site are presented in **Figure F-2**.

Figure 5.6-1 Ecological Conceptual Site Model
SENECA ARMY DEPOT ACTIVITY



EXPOSURE ROUTE	Mammal	Bird	Aquatic
Inhalation	○	○	—
Inhalation	○	○	—
Ingestion	●	●	—
Dermal Contact	○	○	—
Ingestion	●	●	—
Ingestion	○	○	—
Dermal Contact	○	○	—
Ingestion	○	○	—
Dermal Contact	○	○	—
Ingestion	—	—	—
Inhalation	—	—	—
Dermal Contact	—	—	—

LEGEND

→ = Pathways, both current and historical
● = Principal Pathways for quantitative evaluation
○ = Pathways for qualitative evaluation
— = Incomplete pathways

The CSM will serve as a conceptual hypothesis for the exposure characterization, the objective of which is to gather information from which to determine the pathways and media through which ecological receptors may be exposed to COPCs. The exposure characterization typically involves determining the following (EPA, 1994b):

1. The ecological setting of the site
2. The inventory of constituents that are or may be present at the site
3. The extent and magnitude of the constituent concentrations present, along with spatial and temporal variability of those concentrations
4. The environmental fate and transport of the constituents.

The ecological setting was described in **Section F.6.2.2** and the extent and magnitude of contaminants is presented in **Section F.2**. Environmental fate of the COPCs and the potential exposure pathways are discussed in the following paragraphs.

The primary source of contaminants at the site is the residues that may be present in the soil from prior activities at the site. Contamination, if present, can migrate due to bioturbation or excavation. Volatile compounds can move through the soils. Infiltrating rainwater can leach contaminants and transport them into groundwater, and surface water runoff can also carry contaminants onto adjacent soils or drainage ditches.

Exposure to surface soil contaminants may occur directly through ingestion, inhalation, and/or dermal contact. Chemicals also may migrate further in the environment by a variety of pathways following secondary release from surface soil and deeper soil. The following pathways result from these secondary release mechanisms:

- Suspension and dispersal by the wind of particulate contaminants or contaminants adsorbed to surface soil particles
- Direct volatilization of volatile organic compounds from surface soil to air
- Uptake of soil contaminants by terrestrial organisms
- Transport of chemicals to surface water and sediment by surface runoff of water and soil particles

As shown in the CSM, there are five media through which ecological receptors could be exposed to site-related contaminants: air (dust and vapor), soil, surface water, sediment, and organisms in the food chain. An exposure point is a location where a receptor could potentially come into contact with a contaminated medium. An exposure route is the means by which a receptor comes into contact with a contaminated medium at an exposure point. Exposure to COPCs may occur through the routes of ingestion, inhalation, and dermal contact.

Probable exposure routes (i.e., potentially complete pathways) were identified for each medium based on the physical characteristics of the site and the potential ecological receptors that may occur there. Exposure routes were also identified for ecological receptors. Principal pathways for which analytical data were available for quantitative evaluation of soil COPCs include: ingestion of soil and ingestion of other animals and plants that have accumulated contaminants.

Terrestrial animals could potentially be directly exposed to soil contaminants through ingestion of, dermal contact with, and/or inhalation from site soils. For species such as deer, raccoon, opossum, rabbits, rodents, and birds, such exposures would likely be associated with foraging activities. Burrowing species, such as rabbits, mice, moles, and shrews, would probably receive the greatest exposures among vertebrates. Invertebrates living on and within the soil also may experience significant exposures. Although ingestion is the principal soil exposure route, dermal contact also may be important, particularly for burrowing species. However, the limited dermal permeability database available for ecological receptors and surrogate species precluded quantitative evaluation of the dermal exposure pathway.

Ecological receptors could potentially be exposed to site-related contaminants via the air medium. Contaminants in air may be in the form of vapor from volatile organic compounds, or in particulate form (as dusts or adsorbed to soil particles) suspended by wind. In either form, ecological receptors could be exposed to contaminants through inhalation. However, the lack of applicable inhalation toxicity data for ecological receptors or similar species precluded quantitative evaluation of potential risks.

Plants may be considered ecological receptors as well as a pathway or medium through which wildlife receptors can be exposed to contaminants. Plants may absorb site-related contaminants from soil through their roots. Contaminants absorbed by plants may then be transferred to wildlife when the plants are ingested for food. This exposure pathway was addressed by use of chemical-specific soil-to-plant uptake factors (obtained from the scientific literature) in the animal receptor exposure calculations. No plants on or near the site showed visible signs of stress during the field reconnaissance.

Under the future land use scenarios for the site, it is assumed that contaminated soils may be excavated during construction and distributed on the ground surface. As under current conditions, ecological receptors could potentially be exposed to chemicals in soil through ingestion and dermal contact. Other exposure pathways also were assumed to remain essentially the same as under current conditions, except that possible inhalation exposures are likely to be reduced by paving and vegetation (e.g., lawns). The abundance and diversity of some ecological receptors on the site may likely be reduced due to the development.

F.6.2.4 Analysis Plan

The analysis plan is the final stage of problem formulation. In this step, risk hypotheses presented in the CSM are evaluated to determine how these hypotheses will be assessed using site-specific data. The analysis plan includes three categories of measures to evaluate the risk hypotheses identified in the CSM: measures of effect (also termed measurement endpoints), measures of exposure, and measures of ecosystem and receptor characteristics.

Measures of Effect

Measurement endpoints are measurable responses to a stressor that are related to the valued characteristics chosen as assessment endpoints (EPA, 1992). Assessment endpoints generally refer to characteristics of populations and ecosystems. It is usually impractical to measure changes in these characteristics as part of an assessment. Consequently, measurement endpoints are selected that can be measured and extrapolated to predict effects on assessment endpoints (EPA, 1992). The most appropriate measurement endpoint relating to the assessment endpoint is the lowest concentration of the constituent that, in chronic toxicity tests, is associated with non-lethal effects to a deer mouse or short-tailed shrew. Because the assessment endpoint focuses on maintenance of the population of deer mice, shrews, robins and doves, a measure of effect equivalent to "no effect" would be overly conservative, in that it would reflect protection of the individual, not the population. A more appropriate measure of effect, reflecting population level response, is the lowest non-lethal effect level. Toxicity data from tests that measure responses that influence reproduction, health, and longevity of the mouse will conform to the assessment endpoint. Therefore, the lowest concentration of the constituent that produces such effects will be used as a measure of effects.

Reliable measures of effects are not available for each exposure route for each constituent. Effects from exposure through inhalation and dermal contact are not well developed for ecological receptors; consequently, these exposure routes are analyzed qualitatively.

The measures of ecosystem and receptor characteristics include such characteristics as the behavior and location of the receptor and the distribution of a contaminant, both of which may affect the receptor's exposure to the contaminant. The typical foraging area of the receptor as well as the quality of the habitat in the site have been considered in the estimation of exposure, as discussed in **Section F.6.3.**

Measures of Exposure

Measures of exposure are the amounts, in dosage or concentration, that the receptors are hypothesized to receive. These include concentrations of constituents in the impacted media and concentrations or dosages of the constituents to which the receptor is exposed.

Decision rules are specified for evaluating effects on the assessment endpoints. **Table F-10** shows the decision rules that describe the logical basis for choosing among alternative actions for the assessment endpoints based on the results of the measurement endpoints. Together, the assessment endpoint, measurement endpoint, and decision rule define the following:

- An entity (e.g., deer mouse population)
- A characteristic of the entity (e.g., health of the individuals in the population)
- An acceptable amount of change in the entity (e.g., loss of no more than 20 percent of a population)
- A decision whether the protection goal is or is not met.

For soil exposures, the results of the assessment will be presented in terms of hazard quotients (HQs). The HQ is the ratio of the measured or predicted concentration of an ecological COPC to which the receptors are exposed in an environmental medium, and the measured concentration that adversely affects an organism based on a toxicity threshold. If the measured concentration or estimated dose is less than the concentration or dose expected to have the potential to produce an adverse effect (i.e., the ratio of the two is less than 1), the risk is considered acceptable (protective of the ecological receptor). Any quotient greater than or equal to 1 indicates that the ecological COPC warrants further evaluation to determine the actual likelihood of harm. COCs are selected only after an additional weight-of-evidence evaluation of the conservatism of the exposure assumptions, toxicity values, and uncertainties is conducted.

Due to the ephemeral nature of surface water accumulation in the drainage ditches and the limited exposure of valued ecological receptors to surface water or sediment in the ditches, these media are not quantitatively assessed in this ERA.

Measures of Ecosystem and Receptor Characteristics

Section F.6.3.3 discusses the toxicity values associated with the COPCs. Endpoints stated in terms of specific ecological receptors or exposure classes (groups of species exposed by similar pathways) often require data on the processes that increase or decrease the exposure concentration below or above the measured or predicted environmental concentration. Thus, some quotients incorporate exposure factors (e.g., dietary soil fractions and bioaccumulation factors). **Section F.6.3** discusses exposure factors for the site.

F.6.3 Exposure Assessment

The exposure assessment evaluates potential exposure of ecological receptors to site-related constituents through evaluation of the following:

- Description of the spatial distribution of COPCs
- Description of spatial and temporal distribution of ecological receptors
- Quantification of exposure that may result from overlap of these distributions

Each of these components is discussed below.

F.6.3.1 Constituent Distribution

The extent of measured chemical contamination at the site is restricted to the areas sampled within the site. The area of the SEAD-63 is approximately 4 acres, which is less than 1 percent of the 10,000 acre Depot property. Soil located outside this site is presumed to be relatively clean.

The magnitude of constituent exposures that may be experienced by ecological receptors is affected by the degree of their spatial and temporal associations with the site, as discussed in the following sections.

F.6.3.2 Receptor Distribution

A variety of factors may affect the extent and significance of potential exposures. Receptor exposures are affected by the degree of spatial and temporal association with the site. For example, the receptors' mobility may significantly affect their potential exposures to site-related contaminants. Many species may only inhabit the study area during seasonal periods (e.g., breeding season, non-migratory periods). Non-migratory species may remain in the vicinity throughout the year. These species, particularly those with longer life spans (and usually larger home ranges), have the greatest potential duration of exposure. However, species with small home range sizes have the greatest potential frequency of exposure. Other factors affecting exposures include habitat preference, behavior (e.g., burrowing, rooting, foraging), individual home range size (larger home ranges correspond to far less frequent use of study area), and diet. Diet is of particular importance in exposure as related to (1) food source availability (larger amount of preferred food sources equals a greater potential for receptor usage) and (2) bioaccumulative contaminants. Contaminants that bioaccumulate may also tend to biomagnify in the food chain. This discussed in more detail in the following sections. As a result, predatory species at higher trophic levels may receive their most significant exposures through their prey. However, the possibility of a population of an upper trophic-level predator, or even an individual predator, utilizing the site as a primary source of food is considered extremely remote.

The deer mouse and short-tailed shrew each have a typical home range of approximately 0.15 acres (EPA, 1993). The area of the site is approximately 4 acres, which could constitute 100 percent of the home range of a deer mouse or shrew.

The mourning dove has a typical home range of approximately 29 acres (EPA, 1993). The area of the site is 4 acres; thus, SEAD-63 could represent roughly 12 percent of a mourning dove's home range. Comparatively, a robin's home range is roughly 1 to 2 acres (EPA, 1993), which would suggest that SEAD-63 could constitute 100 percent of its exposure.

F.6.3.3 Quantification of Exposure

Evaluation of the degree to which contaminant and receptor distributions (described in the previous two sections) coincide at the site indicated that the two mammals (i.e., deer mouse and short-tailed shrew) and the two birds (i.e., mourning dove and American robin) are the receptors likely to have the greatest potential exposures to COPCs in soil.

To quantify exposures of terrestrial receptors to each COPC, a daily intake of each constituent was calculated. Conversion of the environmental concentration of each COPC to an estimated daily intake for a receptor at the site was necessary prior to evaluation of potentially toxic effects. For terrestrial animal receptors, calculation of exposure intake rates relied upon determination of an organism's exposure to COPCs found in soil. Exposure rates for the deer mouse and shrew receptors were based upon ingestion of contaminants from this medium and also from consumption of other organisms. The ERA did not attempt to measure potential risk from dermal and/or inhalation exposure pathways given the insignificance of these pathways relative to the major exposure pathways (e.g., ingestion) and due to the scarcity of data available for these pathways.

The first step in measuring exposure rates for terrestrial wildlife was the calculation of food ingestion rates for four indicator species (i.e., the deer mouse, short-tailed shrew, mourning dove, and American robin). The EPA's *Wildlife Exposure Factors Handbook* (EPA, 1993) includes a variety of exposure information for a number of avian, herptile, and mammalian species. Data are directly available for body weight, ingestion rate, and dietary composition for the deer mouse, short-tailed shrew, and the American robin. Data provided for the northern bobwhite were used as a surrogate for the mourning dove.

To provide conservative exposure rate calculations for the deer mouse, the mean body weight of 0.02 kg for the female deer mouse and the maximum food ingestion rate of 0.22 g/g-day (0.0044 kg/day) for a non-lactating mouse were used (EPA, 1993).

To provide conservative exposure rate calculations for the short-tailed shrew, the lowest reported mean body weight of 0.015 kg and the maximum food ingestion rate of 0.6 g/g-day (0.009 kg/day) for a short-tailed shrew were used (EPA, 1993).

For exposure rate calculations for the American robin, the average reported body weight of 0.077 kg and the average food ingestion rate of 1.205 g/g-day (0.093 kg/day) for an American robin were used (EPA, 1993).

For exposure rate calculations for the mourning dove, the average reported body weight of the northern bobwhite of 0.174 kg and the average food ingestion rate of 0.0777 g/g-day (0.01347 kg/day) were used (EPA, 1993).

A site foraging factor (SFF) is calculated to account for the reasonably expected use of an exposure group. Because of the small area of their home ranges and their year-round residence, mice and other small mammals living at most of the sites could potentially use contaminated areas 100 percent of the time. Therefore, a SFF of 1 was used for both the shrew and the mouse. The American Robin is a seasonal visitor to the New York area (mid-April to early November or approximately 7 months). Its home range is approximately 1 acre, and as a result a SFF of 0.583 has been applied to it. Conversely, the Mourning Dove is a year round visitor to New York, but its home range encompasses approximately 29 acres. Given these two factors, a SFF of 0.12 has been used in the calculations completed for the dove.

The *Wildlife Exposure Factors Handbook* (EPA, 1993) also presents average values for intake of animal matter and plant matter for the deer mouse as well as incidental soil ingestion. Soil ingestion has been measured at less than 2 percent of diet (Beyer et al., 1994). As might be expected based on the opportunistic habits of mice, the proportion of animal to plant matter in the diet varies from around 65 percent animal : 35 percent plant to 25 percent animal : 75 percent plant depending on season and region of the country. For this ERA, an approximate average of 50 percent animal : 50 percent plant was used, after subtracting the 2 percent for incidental soil ingestion. The dietary intakes calculated for this assessment are as follows:

Total Dietary Intake = 0.0044 kg food/day

Plant Matter Intake = 0.00216 kg plant matter/day
Animal Matter Intake = 0.00216 kg animal matter/day
Incidental Soil Intake = 0.000088 kg soil/day

The short-tailed shrew is primarily carnivorous, with its diet consisting largely of insects and other invertebrates found in the soil. Based on information provided in EPA 1993, 5.3 percent of the shrew's diet is vegetative, with most of the remainder comprised of soil invertebrates. To be conservative in terms of potential bioaccumulation, it was assumed that 94.7 percent of the shrew's intake is animal matter (small insects, etc.) and none of the intake is soil. Accordingly, the shrew's dietary intakes calculated for this assessment are as follows:

Total Dietary Intake = 0.009 kg food/day
Plant Matter Intake = 0.00048 kg plant matter/day
Animal Matter Intake = 0.00852 kg animal matter/day
Incidental Soil Intake = 0 kg soil/day

The American Robin's diet includes ground dwelling invertebrates, foliage dwelling insects and fruits. The robin's diet varies significantly throughout the year, exhibiting a high insect and invertebrate intake in the spring and a high plant material intake characteristic in the fall. Averaging the dietary characteristics over these three seasons results in an average invertebrate intake of 44 % and an average plant material intake of 56%. Soil ingestion for the American woodcock (surrogate species) has been measured at approximately 10.4 percent of diet (Beyer et al., 1994). For this ERA, an approximate average of 44 percent invertebrate : 56 percent plant was used, after subtracting the 10.4 percent for incidental soil ingestion. The dietary intakes calculated for this assessment are as follows:

Total Dietary Intake = 0.093 kg food/day
Plant Matter Intake = 0.0466 kg plant matter/day
Invertebrate Matter Intake = 0.0366 kg animal matter/day
Incidental Soil Intake = 0.0096 kg soil/day

The dietary habits of the mourning dove are based on information provided in EPA 1993 for the northern bobwhite. Over the course of the year, the average food ingestion rate for the mourning dove is 0.0778 g/g-day (0.0122 kg/day). Of this material, approximately 85 percent of it is derived from plant matter while the balance is derived from invertebrates. Soil ingestion is estimated at approximately 10.4 percent of diet (Beyer et al., 1994). For this ERA, an approximate average of 15 percent invertebrate : 85 percent plant was used, after subtracting the 1.3 percent for incidental soil ingestion. The dietary intakes calculated for this assessment are as follows:

Total Dietary Intake = 0.01221 kg food/day
Plant Matter Intake = 0.00164 kg plant matter/day
Invertebrate Matter Intake = 0.00931 kg animal matter/day
Incidental Soil Intake = 0.00125 kg soil/day

A summary of species intake factors used for the subject mammals and birds is provided in **Table F-11.**

A site-specific exposure dose of each COPC was calculated using a food chain uptake model consistent with EPA Region IV guidance (EPA, 1995). This algorithm accounts for exposure via incidental ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and ingestion of lower trophic level animals associated with contamination. The exposure equation for soil is as follows:

$$ED_{soil} = [(C_s \times SP \times CF \times I_p) + (C_s \times BAF \times I_a) + (C_s \times I_s)] \times SFF / BW$$

where:

ED_{soil} = Soil exposure dose for terrestrial receptor (mg/kg/day)
C_s = RME concentration in soil (mg/kg)
SP = Soil-to-plant uptake factor (unitless)
CF = Plant wet-weight-to-dry-weight conversion factor (unitless) = 0.2 (used for SP values based on plant dry weight)
I_p = Receptor-specific ingestion rate of plant material (kg/day)
BAF = Constituent-specific bioaccumulation factor (unitless)
I_a = Receptor-specific ingestion rate of animal material (kg/day)
I_s = Receptor-specific ingestion rate of soil (kg/day)
SFF = Site foraging factor (unitless) = 1 (see explanation below)
BW = Body weight (kg)

In evaluating the potential for a contaminant to pose ecological risk, it is important to consider its propensity for bioaccumulation even though its concentration in an environmental medium may be below toxic levels. Therefore, all COPCs were evaluated with regard to their ecological persistence and tendency to bioaccumulate.

Bioaccumulation is the process of absorption and retention of a substance by an organism due to both uptake from water (or other surrounding media) and uptake from ingested residues in food, soil, and/or sediment. It is quantified by the calculation of a bioaccumulation factor (BAF).

TABLE F-11
WILDLIFE INTAKE FACTORS
SEAD-63 EE/CA
Seneca Army Depot Activity

Receptor Seneca Army Depot	Body Weight (kg) (3)	Trophic Level(1)	Foraging Factor(2)	Dietary Intake Breakdown (3)			
				Plant (kg/day) Ip	Animal (kg/day) Ia	Soil (kg/day) Is	Surface Water (L/day) Iw
SEAD-63							
Deer Mouse (3)	0.020	3	1	0.00216	0.00216	0.000088	--
Short-tailed Shrew (3)	0.015	3	1	0.00048	0.00852		0.00330
American Robin (3)	0.077	3	0.583	0.03658	0.04656	0.00965	0.0106
Mourning Dove (3)	0.157	2	0.1204	0.00931	0.00164	0.00125	--

(1) Trophic level: organisms are assigned to trophic levels of 1 (producer), 2 (herbivore), 3 (1st order carnivore), and 4 (top carnivore) within the food web.

(2) Foraging factor: adjustment factor (from 0 to 1) based upon an organism's total time of exposure to unit-based contaminants. Foraging factor includes consideration of foraging range and period of occupancy in an area. If the foraging range is smaller than the identified size of the SEAD (~ 3.44 acres), a factor of 1 is applied. If the species is only present in an area during part of the year a seasonal occupancy factor is applied. Based on information provided in Wildlife Exposure Factors Handbook US EPA 1993 and 1997.
Deer Mouse is a year round resident; Home range = less than 1 acre
Deer Mouse SFF = (3.44 acre / 1 acre home range mouse) or 1 x (12 months/ 12 months/year) = 1.0
Short-tailed shrew is a year round resident; Home range = less than 1 acre
Deer Mouse SFF = (3.44 acre / 1 acre home range mouse) or 1 x (12 months/ 12 months/year) = 1.0
American Robin in New York mid-April through early November (7 months); Home range = 1.1 acres. SFF = 1 x 7/12 = .583
American Robin SFF = (3.44 acre / 1 acre home range robin) or 1 x (7 months/ 12 months/year) = 0.583
Mourning Dove in New York all year (12 months); Home range = 28.6 acres
Mourning Dove SFF = (3.44 acre / 28.6 acre home range dove) X (12 months /12 months) = 0.1204

(3) Deer Mouse body weight and plant matter, animal matter, and surface water ingestion rates from Wildlife Exposure Factors Handbook USEPA 1993 and USEPA 1997; soil intake rate based on Beyer et al. (1994).
Short-tail Shrew body weight and plant matter, animal matter, and surface water ingestion rates from Wildlife Exposure Factors Handbook USEPA 1993 and USEPA 1997.
American Robin body weight and plant matter, animal matter, and surface water ingestion rates from Wildlife Exposure Factors Handbook USEPA 1993 and USEPA 1997; soil intake rate (i.e., 10.4%) based on American woodcock in Beyer et al. (1994).
Mourning Dove body weight and plant matter and animal matter ingestion rates based on northern bobwhite in USEPA (1998); soil intake rate (i.e., 10.4%) based on American woodcock in Beyer et al. (1994).

Bioconcentration is a component of bioaccumulation, accounting only for the process of uptake from the surrounding medium (usually water). It is quantified by the calculation of a bioconcentration factor (BCF). Both BAFs and BCFs are proportionality constants relating the concentration of a contaminant in the tissues of an organism to the concentration in the surrounding environment (Amdur et al., 1991; EPA, 1989).

Bioaccumulation and bioconcentration may be a significant component of exposure to COPCs for the terrestrial receptors. For the species considered in this ERA (i.e., deer mouse, short-tailed shrew, American robin, and mourning dive), bioaccumulation was evaluated by means of contaminant-specific soil-to-plant uptake factors and BAFs. The soil-to-plant uptake factors were obtained from NRC (1992) for metals and for organic compounds by using a regression equation from Travis and Arms (1988). The latter is based on the contaminant-specific octanol/water partition coefficient (log K_{OW}). BAFs were obtained from the scientific literature. Factors reflecting accumulation of COPCs in earthworms were preferentially selected, based on the feeding habits of the deer mouse, shrew and robin. **Table F-12** shows values for soil-to-plant uptake factors and BAFs.

F.6.3.4 Effects Assessment

The effects assessment defines and evaluates the potential ecological response to ecological COPCs in terms of the selected assessment and measurement endpoints. The effects assessment for soil exposure includes the derivation of toxicity reference values (TRVs) that are the basis of the comparison. **Section F.6.4** uses the results of the toxicity assessment to identify ecological COCs and characterize ecological risk.

For soil, the methodology for assessing the potentially toxic effects of COPCs was based on the derivation of a TRV for each COPC. The TRVs were derived to represent reasonable estimates of the constituent concentrations that, if exceeded, may produce toxicity effects in ecological receptors exposed to soil. Ideally, TRV values would be based on site-specific toxicity data. However, in the absence of site-specific data, toxicity data from the literature were used by establishing data selection criteria such that TRVs would be as relevant as possible to assessment endpoints for this site. Furthermore, the conservativeness of the TRVs was reinforced by using the lowest available, appropriate toxicity values and modifying them by uncertainty factors when necessary. The derivation of TRVs for soil is shown in **Table F-13** for mammals and **Table F-14** for birds.

The toxicity benchmarks used as effects thresholds for the evaluation of the assessment endpoint (maintenance of healthy populations of small mammals) are based on NOAELs for test organisms (Sample et al., 1996). The NOAEL (no observed adverse effect level) is the highest

Table F-12

ENVIRONMENTAL FATE AND TRANSPORT PROPERTIES FOR CHEMICALS OF POTENTIAL CONCERN

Action Memorandum/EE/CA - SEAD-63

Seneca Army Depot Activity

	Soil to Plant Transfer Factors (STP)			Trophic Level 2 BAF (invertebrates)	
Constituent	logKow (1)	STP (2)	Source	BAF	Source
Volatile Organics					
Acetone	-0.24	5.33E+01	Travis & Arms 1988	3.90E-01	Sample et al., 1996
Benzene	2.11	2.34E+00	Travis & Arms 1988	2.45E+01	Sample et al., 1996
Methyl ethyl ketone	0.26	2.74E+01	Travis & Arms 1988	9.60E-01	Sample et al., 1996
Toluene	2.5	1.39E+00	Travis & Arms 1988	7.24E+01	Sample et al., 1996
Total Xylenes	3.18	5.62E-01	Travis & Arms 1988	6.00E+00	ATSDR 1990
Semivolatile Organics					
Benzo(a)anthracene	5.9	1.51E-02	Travis & Arms 1988	1.25E-01	Beyer 1990
Benzo(a)pyrene	6.04	1.02E+00	USEPA 1994	4.50E+00	Beyer 1990
Benzo(b)fluoranthene	6.57	6.17E-03	Travis & Arms 1988	3.20E-01	Beyer 1990
Benzo(k)fluoranthene	6.85	4.25E-03	Travis & Arms 1988	2.53E-01	Beyer 1990
Chrysene	5.61	2.22E-02	Travis & Arms 1988	1.75E-01	Beyer 1990
Dibenz(a,h)anthracene	6.36	8.16E-03	Travis & Arms 1988	3.68E-01	Beyer 1990
Fluoranthene	5.22	3.72E-02	Travis & Arms 1988	7.92E-01	Beyer 1990
Fluorene	4.12	1.61E-01	Travis & Arms 1988	3.42E-01	Beyer 1990
Indeno(1,2,3-cd)pyrene	7.7	1.37E-03	Travis & Arms 1988	4.19E-01	Beyer 1990
2-Methylnaphthalene	4.11	1.63E-01	Travis & Arms 1988	3.42E-01	Beyer 1990 (BAP as surrogate)
Naphthalene	3.36	4.43E-01	Travis & Arms 1988	3.42E-01	Beyer 1990 (BAP as surrogate)
Phenanthrene	4.46	1.02E-01	Travis & Arms 1988	1.22E-01	Beyer 1990
Pyrene	5.09	4.43E-02	Travis & Arms 1988	9.20E-02	Beyer 1990
Semi-volatiles					
bis(2-Ethylhexyl)phthalate	4.2	5.10E-03	USEPA 1994	1.20E+01	USEPA 1994
Butylbenzylphthalate	4.78	5.60E-02	Calculated	1.00E+00	Default
Carbazole	1	1.00E+00	Default	1.15E+02	AQUIRE 1997
Dibenzofuran	4.17	1.51E-01	Travis & Arms 1988	1.00E+00	Default
Diethyl phthalate	3	7.14E-01	Travis & Arms 1988	1.17E+00	AQUIRE 1997
Di-n-butylphthalate	4.31	1.25E-01	Travis & Arms 1988	1.25E+00	USEPA 1994 (BEHP as surrogate)
Di-n-octylphthalate	9.2	1.60E-04	USEPA 1994	4.90E+03	USEPA 1994
Phenol	1.48	5.40E+00	Travis & Arms 1988	1.00E+00	Default
Pesticides					
4,4'-DDD	5.99	1.34E-02	Travis & Arms 1988	1.00E-01	USEPA 1994 (DDT as surrogate)
4,4'-DDE	5.766	1.80E-02	Travis & Arms 1988	2.50E-02	Menzie et al., 1992
4,4'-DDT	5.9	1.00E-02	USEPA 1994	1.00E-01	USEPA 1994
Endosulfan I	3.55	3.44E-01	Travis & Arms 1988	2.50E-01	Menzie et al., 1992
Endosulfan sulfate	3.66	2.97E-01	Travis & Arms 1988	2.50E-01	Menzie et al., 1992
Endrin ketone	5.06	2.20E-02	USEPA 1995	1.80E-01	USEPA 1994 (endrin as surrogate)
Metals					
Cadmium	NA	5.50E-01	NRC 1992	2.15E-02	Ash and Lee, 1980
Sodium	NA	1.00E+00	Default	1.00E+00	Default

Notes

(1) Logarithmic value of octonol-water partition coefficient. LogKow source: Montgomery, J.H. and L.M. Welkorn. *Groundwater Chemicals Desk Reference*, 1989

(2) Soil to plant uptake factor. For organic chemicals without reported STP values, the STP was estimated from the Kow as follows:

logSTP = 1.588 - 0.578 x logKow (Travis and Arms 1988)

(3) This table includes STP and BAF factor information available from Parsons ES-Tampa current database (8/99)

(4) BAF = Bioaccumulation factor

(5) For chemicals without reported STP or BAF values, surrogate or default values were assigned based on best professional judgement

Table F-13
NOAEL TOXICITY REFERENCE VALUES - MAMMALS
Decision Document - Mini Risk Assessment
Seneca Army Depot Activity

Constituent	Test Organism	Endpoint/Duration/Effect	Source	Effect Dose (mg/kg/day)	Endpoint CF(1)	Study Duration CF(1)	Total CF(1)	TRV(2) (mg/kg/day)
Volatile Organics								
Acetone	rat	NOAEL, gavage, 90-day, liver and kidney damage	Sample et al. 1996	100	1	10	10	10
Benzene	mouse	LOAEL, oral gavage, days 6-12 gestation crit lifestage, reproduction	Sample et al. 1996	263.6	10	1	10	26.36
Methyl ethyl ketone	rat	NOAEL, water, 2 generations, reproduction	Sample et al 1996	1771	10	1	10	177.1
Toluene	mouse	LOAEL, gavage, day 6-12 gestation crit. lifestage, reproduction	Sample et al. 1996	260	10	1	10	26
Total Xylenes	mouse	NOAEL, gavage, day 6-15 gestation crit. lifestage, reproduction	Sample et al. 1996	2.1	1	1	1	2.1
PAHs								
Benzo(a)anthracene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al 1996	10	10	1	10	1
Benzo(a)pyrene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction	Sample et al. 1996	10	10	1	10	1
Benzo(b)fluoranthene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al 1996	10	10	1	10	1
Benzo(k)fluoranthene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al. 1996	10	10	1	10	1
Chrysene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al. 1996	10	10	1	10	1
Dibenz(a,h)anthracene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al. 1996	10	10	1	10	1
Fluoranthene	mouse	LOAEL, oral gavage, 13 wks., hepatic effects	ATSDR 1995	125	10	10	100	1.25
Fluorene	mouse	LOAEL, oral gavage, 13 wks., hepatic effects	ATSDR 1995	125	10	10	100	1.25
Indeno(1,2,3-cd)pyrene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al. 1996	10	10	1	10	1
2-Methylnaphthalene	mouse	LOAEL, diet, 81 wks., respitory (naphthalene used as surrogate)	ATSDR 1995	71.6	10	1	10	7.16
Naphthalene	mouse	LOAEL, diet, 81 wks., respitory	ATSDR 1995	71.6	10	1	10	7.16
Phenanthrene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al. 1996	10	10	1	10	1

Table F-13
NOAEL TOXICITY REFERENCE VALUES - MAMMALS
Decision Document - Mini Risk Assessment
Seneca Army Depot Activity

Constituent	Test Organism	Endpoint/Duration/Effect	Source	Effect Dose (mg/kg/day)	Endpoint CF[(1)]	Study Duration CF[(1)]	Total CF[(1)]	TRV[(2)] (mg/kg/day)
Pyrene	mouse	LOAEL, oral intubation, gestation days 7-16 crit. lifestage, reproduction (benzo(a)pyrene used as surrogate)	Sample et al. 1996	10	10	1	10	1
Semi-volatiles								
bis(2-ethylhexyl)phthalate	mouse	NOAEL, diet, 105 days crit. lifestage, reproduction	Sample et al. 1996	18.33	1	1	1	18.33
Butlybenzylphthalate	rat	NOAEL, diet, 6 months, reproduction, liver weight, blood chemistry	IRIS, 1999	159	1	1	1	159
Carbazole	rat	LD50, oral		500	10	10	100	5
Dibenzofuran	mammal	No data available					--	no data
Diethylphthalate	mouse	NOAEL, diet, 105 day crit. lifestage, reproduction	Sample et al. 1996	4583	1	1	1	4583
Di-n-butylphthalate	mouse	NOAEL, diet, 105 days crit. lifestage, reproduction	Sample et al. 1996	550	1	1	1	550
Di-n-octylphthalate	mouse	NOAEL, diet, 105 days crit. lifestage, reproduction (BEHP as surrogate)	Sample et al. 1996	18.33	1	1	1	18.33
Phenol		No data available					--	no data
Pesticides/PCBs								
4,4'-DDD	rat	NOAEL, diet, 2 year crit. lifestage, reproduction (DDT used as surrogate)	Sample et al. 1996	0.8	1	1	1	0.8
4,4'-DDE	rat	NOAEL, diet, 2 year crit. lifestage, reproduction (DDT used as surrogate)	Sample et al. 1996	0.8	1	1	1	0.8
4,4'-DDT	rat	NOAEL, diet, 2 year crit. lifestage, reproduction	Sample et al. 1996	0.8	1	1	1	0.8
Endosulfan I	mouse	NOAEL, diet, 78-week, renal effects	ATSDR, 1990e	0.5	1	1	1	0.5
Endosulfan sulfate	mouse	Used endosulfan as surrogate		2.5	10	1	10	0.25
Endrin ketone	mouse	LOAEL, diet, 120-day, reproduction (Endrin)		0.92	10	1	10	0.092
Metals								
Cadmium	rat	NOAEL, gavage, 6 weeks mating and gestation crit. lifestage, reproduction	Sample et al. 1996	1	1	1	1	1
Sodium		No data available					--	no data

Notes:

(1) CF = conversion factor. Conversion factors - endpoint (non-NOAEL = 10) and study duration (non-chronic = 10)

(2) The toxicity reference value was derived by dividing the effect dose by the total conversion factor.

(3) This table includes TRV factor information available from Parsons ES-Tampa current database (8/99).

(4) V = Volatile (MW<200, H>1E-05); SV = Semi-Volatile; PAH = Polynuclear Aromatic Hydrocarbon; PES = Pesticide; PCB = Polychlorinated Biphenyl; ING = Inorganic

(5) Mammals: acute = <90days, subchronic = 90days - 1yr, chronic = >1yr. Birds: acute = <18days, subchronic = 18days - 10wks, chronic = >10wks. Source: Sample et al. 1996
If the study is during a critical life stage (gestation or development), the study may be considered a chronic exposure.

(6) The product of the appropriate uncertainty factors from each uncertainty category becomes the total uncertainty factor applied to develop the constituent-specific TRV.

TABLE F-14
NOAEL Toxicity Reference Values - Soil Receptors (Birds)
SEAD 63
Seneca Army Depot Activity

Constituent	Test Organism	Endpoint/Duration/Effect	Source	Effect Dose (mg/kg/day)	Endpoint CF[1]	Study Duration CF[1]	Total CF[1]	TRV[2] (mg/kg/day)
Volatiles								
Acetone	Japanese quail	NOAEL, 14-day old, diet, 5 days, survival	Hill and Camardese 1986	6.10E+03	1	10	10	6.10E+02
Benzene		No data available						
Methyl ethyl ketone		No data available						
Toluene		No data available						
Total Xylenes	Japanese quail	NOAEL, 14-day old chicks, diet, 5 days, survival	Hill and Camardese 1986	3.06E+03	1	10	10	3.06E+02
PAHs								
Benzo(a)anthracene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Benzo(a)pyrene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Benzo(b)fluoranthene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Benzo(k)fluoranthene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Chrysene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Dibenz(a,h)anthracene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Fluoranthene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Fluorene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Indeno(1,2,3-cd)pyrene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
2-Methylnaphthalene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Naphthalene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Phenanthrene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Pyrene	mallard	LOAEL, diet, 7 months, physiological (mixed PAHs used as surrogate)	Eisler 1987	2.85E+02	10	1	10	2.85E+01
Semi-volatiles								
Bis(2-ethylhexyl)phthalate	ringed dove	NOAEL, diet, 4 wks, crit. lifestage, reproduction	Sample et al. 1996	1.10E+00	1	10	10	1.10E-01
Butylbenzylphthalate		No data available						
Carbazole		No data available						
Dibenzofuran	red-winged blackbird	LC50, diet, 18 hours, survival	Schafer et al. 1983.	2.18E+01	10	10	100	2.18E-01
Diethyl phthalate	ringed dove	NOAEL, diet, 4 wks, crit. lifestage, reproduction (di-n-butyl-phthalate used as surrogate)	Sample et al. 1996	1.10E-01	1	10	10	1.10E-02
Di-n-butylphthalate	ringed dove	NOAEL, diet, 4 wks, crit. lifestage, reproduction	Sample et al. 1996	1.10E-01	1	10	10	1.10E-02
Di-n-octylphthalate	ringed dove	NOAEL, diet, 4 wks, crit. lifestage, reproduction (Di-n-butylphthalate as surrogate)	Sample et al. 1996	1.10E-01	1	10	10	1.10E-02
Phenol		No data available						

TABLE F-14
NOAEL Toxicity Reference Values - Soil Receptors (Birds)
SEAD 63
Seneca Army Depot Activity

Constituent	Test Organism	Endpoint/Duration/Effect	Source	Effect Dose (mg/kg/day)	Endpoint CF[1]	Study Duration CF[1]	Total CF[1]	TRV[2] (mg/kg/day)
Pesticides								
4,4'-DDD	Japanese quail	NOAEL, diet, 10 week, reproduction (DDT used as surrogate)	Sample et al. 1996	5.60E-01	1	10	10	5.60E-02
4,4'-DDE	Japanese quail	NOAEL, diet, 12 wks, reproduction, liver effects	Sample et al. 1996	5.60E-01	1	10	10	5.60E-02
4,4'-DDT	Japanese quail	NOAEL, diet, 10 week, reproduction	Sample et al. 1996	5.60E-01	1	10	10	5.60E-02
Endosulfan I	gray partridge	NOAEL, diet, 4 wks crit. lifestage, reproduction (endosulfan as surrogate)	Sample et al. 1996	1.00E+01	1	10	10	1.00E+00
Endosulfan sulfate	gray partridge	NOAEL, diet, 4 wks crit. lifestage, reproduction (endosulfan as surrogate)	Sample et al. 1996	1.00E+01	1	10	10	1.00E+00
Endrin ketone	mallard	NOAEL, diet, >200 days, crit. lifestage, reproduction (endrin as surrogate)	Sample et al. 1996	3.00E-01	1	1	1	3.00E-01
Metals								
Cadmium	mallard	NOAEL, diet, 90 days, reproduction	Sample et al. 1996	1.45E+00	1	1	1	1.45E+00
Sodium		No data available						

1 CF = conversion factor.

2 The toxicity reference value was derived by dividing the effect dose by the total conversion factor.

exposure concentration at which no harmful effects were observed. Use of the NOAEL as the toxicity benchmark is more conservative than use of the LOAEL (lowest observed adverse effect level). Exposure of receptors to the LOAEL has been predicted to translate into less than 20 percent reduction in population size (Suter et al., 1994) or Lowest Observed Effects Concentrations.

For the terrestrial receptor, the order of taxonomic preference when choosing TRVs was data from studies using (1) native small mammal species potentially present at the site, or (2) proxy species, such as commonly studied laboratory species. The preferred toxicity test endpoint was the NOAEL from an appropriate chronic study for non-lethal or reproductive effects. When NOAEL values were not available, LOAELs for were used, as available. Values based on chronic studies were preferred. Studies were considered to provide chronic toxicity data if conducted for a minimum duration of 1 year in mammals. Studies longer than acute but shorter than chronic are considered subchronic. Studies shorter than 90 days in mammals were considered acute. Studies on developmental effects were considered chronic if conducted during a critical gestation period.

The toxicity values selected by this approach were modified through the application of uncertainty factors, as applicable, to derive a TRV for each COPC. The TRVs represent NOAELs with uncertainty factors incorporated for toxicity information derived from studies other than chronic studies and studies on species other than the receptors selected for this risk assessment. Where only a LOAEL was available, an uncertainty factor of 10 was applied, as recommended by EPA Region II, to represent a surrogate NOAEL. In addition, where toxicity information for a surrogate contaminant was used, an uncertainty factor of 10 was applied. Uncertainty factors were applied by dividing the initial toxicity value by the product of the necessary uncertainty factors. Uncertainty factors are listed in **Tables F-13** and **F-14** with the TRVs developed for shallow soil/sediment COPCs.

F.6.4 Risk Characterization

Risk characterization integrates exposure(s) and effect(s) on receptors using hazard quotients (HQs) (ratios of exposure and effect concentrations). The resulting data are used to define the magnitude of risk from ecological COPCs at the site and to assess the risk to ecological receptors. Risk characterization uses the results of the exposure and effects assessments to calculate an HQ for each COPC. The HQs are based on relevant measurement endpoints and are indicative of the COPC's potential to pose ecological risk to receptors. Any COPCs for a given exposure group and medium that were identified as likely to pose significant risk to receptors based on their HQs were classified as ecological chemicals of concern (COCs). Risk assessment related uncertainties are also analyzed and discussed.

Estimation of a COPC's potential to pose significant risk to receptors is based on the magnitude of the HQ value calculated for each constituent, as well as other factors such as the bioaccumulation/biomagnification potential, mechanism of toxicity, physicochemical characteristics, environmental fate, and ecological relevance of each contaminant. The HQ is a ratio of the estimated exposure dose (for terrestrial receptors) of a constituent to the TRV. Generally, a higher ratio or quotient indicates a greater likelihood of an effect. Typically, a quotient of 1 is considered the threshold level at which effects may occur. The TRVs on which the HQs were based were derived to be conservative and representative of chronic exposures, as described previously in **Section F.6.3.3.**

The calculated HQs were used to assess the potential that toxicological effects will occur among the site's receptors. The HQs were compared to HQ guidelines for assessing the risk posed from contaminants (Menzie et al., 1993). These guidelines suggest that HQs less than or equal to 1 present no probable risk; HQs from 1 up to, but less than, 10 present a small potential for environmental effects; HQs from 10 up to, but less than 100 present a significant potential for ecological effects, and HQs greater than 100 present the highest potential for expected effects. The likelihood that a population of deer mice or short-tailed shrews could be significantly impacted by the toxicological effect(s) produced by a given COPC was a major factor in the subsequent determination (in **Section F.6.3.3**) of whether that contaminant should be classified as an ecological COC.

Ecological risk from COPCs was characterized for potential future land use at the site. Risks from constituents found in soil available to terrestrial receptors were assessed quantitatively. Complete exposure calculations for the site are included in **Tables F-15** (mammals) and **F-16** (birds). The hazard quotients calculated for the site are also summarized in **Table F-17** (mammals) and **Table F-18** (birds). Significant findings are summarized in the sections below.

TABLE F-15
CALCULATED SURFACE SOIL/SEDIMENT (0-2' bls) EXPOSURE - MAMMALS
SEAD-63
Seneca Army Depot Activity

Constituent	Max Detected Conc. (mg/kg)	SP[1] (unitless)	BAF[2] (unitless)	Deer Mouse Max Exposure[3] (mg/kg/day)	Shrew Max Exposure[3] (mg/kg/day)
Volatiles					
Acetone	1.50E-01	5.33E+01	3.90E-01	8.70E-01	2.87E-01
Benzene	2.00E-03	2.34E+00	2.45E+01	5.81E-03	2.80E-02
Methyl ethyl ketone	3.50E-02	2.74E+01	9.60E-01	1.07E-01	4.96E-02
Toluene	1.40E-02	1.39E+00	7.24E+01	1.12E-01	5.77E-01
Total Xylenes	1.40E-02	5.62E-01	6.00E+00	9.98E-03	4.80E-02
PAHs					
Benzo(a)anthracene	2.00E+00	1.51E-02	1.25E-01	3.91E-02	1.43E-01
Benzo(a)pyrene	2.70E+00	1.02E+00	4.50E+00	1.62E+00	6.99E+00
Benzo(b)fluoranthene	3.50E+00	6.17E-03	3.20E-01	1.39E-01	6.37E-01
Benzo(k)fluoranthene	1.90E+00	4.25E-03	2.53E-01	6.11E-02	2.73E-01
Chrysene	2.20E+00	2.22E-02	1.75E-01	5.65E-02	2.20E-01
Dibenz(a.h)anthracene	1.20E+00	8.16E-03	3.68E-01	5.40E-02	2.51E-01
Fluoranthene	4.30E+00	3.72E-02	7.92E-01	4.04E-01	1.94E+00
Fluorene	1.10E-01	1.61E-01	3.42E-01	6.46E-03	2.19E-02
Indeno(1.2.3-cd)pyrene	2.50E+00	1.37E-03	4.19E-01	1.25E-01	5.95E-01
2-Methylnaphthalene	1.40E-02	1.63E-01	3.42E-01	8.25E-04	2.79E-03
Naphthalene	2.30E-02	4.43E-01	3.42E-01	2.05E-03	4.79E-03
Phenanthrene	1.50E+00	1.02E-01	1.22E-01	4.29E-02	1.09E-01
Pyrene	3.20E+00	4.43E-02	9.20E-02	6.12E-02	1.72E-01
Semi-volatiles					
Bis(2-ethylhexyl)phthalate	1.80E+00	5.10E-03	1.20E+01	2.34E+00	1.23E+01
Butylbenzylphthalate	1.20E-01	5.60E-02	1.00E+00	1.42E-02	6.84E-02
Carbazole	4.30E-01	1.00E+00	1.15E+02	5.39E+00	2.81E+01
Dibenzofuran	3.60E-02	1.51E-01	1.00E+00	4.63E-03	2.06E-02
Diethyl phthalate	9.20E-02	7.14E-01	1.17E+00	1.91E-02	6.33E-02
Di-n-butylphthalate	1.20E-01	1.25E-01	1.25E+00	1.83E-02	8.57E-02
Di-n-octylphthalate	1.90E-02	1.60E-04	4.90E+03	1.01E+01	5.29E+01
Phenol	9.30E-02	5.40E+00	1.00E+00	6.47E-02	6.88E-02
Pesticides					
4,4'-DDD	3.90E-03	1.34E-02	1.00E-01	6.49E-05	2.23E-04
4,4'-DDE	9.20E-03	1.80E-02	2.50E-02	8.32E-05	1.36E-04
4,4'-DDT	8.30E-03	1.00E-02	1.00E-01	1.35E-04	4.74E-04
Endosulfan I	7.50E-03	3.44E-01	2.50E-01	5.14E-04	1.15E-03
Endosulfan sulfate	5.20E-03	2.97E-01	2.50E-01	3.30E-04	7.88E-04
Endrin ketone	9.40E-03	2.20E-02	1.80E-01	2.46E-04	9.68E-04
Metals					
Cadmium	8.30E-01	5.50E-01	2.15E-02	1.54E-02	1.30E-02
Sodium	5.78E+02	1.00E+00	1.00E+00	7.75E+01	3.32E+02

1 SP: soil-to-plant uptake factor.

2 BAF: bioaccumulation factor.

3 Exposure calculated as

ED = [(Cs * SP * CF * Ip) + (Cs * BAF * Ia) + (Cs * Is)] * SFF / BW

Where, ED = exposure dose

Cs = maximum or mean concentration in soil (mg/kg)
CF = plant dry-to-wet-weight conversion factor (0.2) for inorganics only
SP = soil-to-plant uptake factor for vegetative matter
Ip = plant-matter intake rate; Mouse = 0.00216 kg/day. Shrew = 0.000477 kg/day
BAF = invertebrate bioaccumulation factor (unitless)
Ia = animal-matter intake rate. Mouse = 0.00216 kg/day. Shrew = 0 008523 kg/day.
Is = incidental soil intake rate: Mouse = 0.000088 kg/day. Shrew = 0 kg/day
SFF = site foraging factor = 1
BW = body weight; Mouse = 0 02 kg. Shrew = 0.015 kg

TABLE F-16
CALCULATED SURFACE SOIL/SEDIMENT (0-2' bls) EXPOSURE - BIRDS
SEAD 63
Seneca Army Depot Activity

Constituent	Max Detected Conc. (mg/kg)	SP[1] (unitless)	BAF[2] (unitless)	Robin Max Exposure[3] (mg/kg/day)	Dove Max Exposure[3] (mg/kg/day)
Volatiles					
Acetone	1.50E-01	5.33E+01	3.90E-01	2.25E+00	5.83E-02
Benzene	2.00E-03	2.34E+00	2.45E+01	1.87E-02	1.10E-04
Methyl ethyl ketone	3.50E-02	2.74E+01	9.60E-01	2.80E-01	7.15E-03
Toluene	1.40E-02	1.39E+00	7.24E+01	3.64E-01	1.52E-03
Total Xylenes	1.40E-02	5.62E-01	6.00E+00	3.28E-02	2.66E-04
PAHs					
Benzo(a)anthracene	2.00E+00	1.51E-02	1.25E-01	2.43E-01	1.53E-02
Benzo(a)pyrene	2.70E+00	1.02E+00	4.50E+00	5.24E+00	5.50E-02
Benzo(b)fluoranthene	3.50E+00	6.17E-03	3.20E-01	6.56E-01	2.75E-02
Benzo(k)fluoranthene	1.90E+00	4.25E-03	2.53E-01	3.10E-01	1.47E-02
Chrysene	2.20E+00	2.22E-02	1.75E-01	3.10E-01	1.71E-02
Dibenz(a,h)anthracene	1.20E+00	8.16E-03	3.68E-01	2.46E-01	9.51E-03
Fluoranthene	4.30E+00	3.72E-02	7.92E-01	1.56E+00	3.73E-02
Fluorene	1.10E-01	1.61E-01	3.42E-01	2.62E-02	9.88E-04
Indeno(1,2,3-cd)pyrene	2.50E+00	1.37E-03	4.19E-01	5.53E-01	1.98E-02
2-Methylnaphthalene	1.40E-02	1.63E-01	3.42E-01	3.34E-03	1.26E-04
Naphthalene	2.30E-02	4.43E-01	3.42E-01	7.27E-03	2.53E-04
Phenanthrene	1.50E+00	1.02E-01	1.22E-01	2.17E-01	1.24E-02
Pyrene	3.20E+00	4.43E-02	9.20E-02	3.77E-01	2.51E-02
Semi-volatiles					
Bis(2-ethylhexyl)phthalate	1.80E+00	5.10E-03	1.20E+01	7.75E+00	4.06E-02
Butylbenzylphthalate	1.20E-01	5.60E-02	1.00E+00	5.29E-02	1.09E-03
Carbazole	4.30E-01	1.00E+00	1.15E+02	1.76E+01	6.86E-02
Dibenzofuran	3.60E-02	1.51E-01	1.00E+00	1.68E-02	3.50E-04
Diethyl phthalate	9.20E-02	7.14E-01	1.17E+02	3.82E+00	1.47E-02
Di-n-butylphthalate	1.20E-01	1.25E-01	1.25E-01	1.82E-02	1.01E-03
Di-n-octylphthalate	1.90E-02	1.60E-04	4.90E+03	3.28E+01	1.17E-01
Phenol	9.30E-02	5.40E+00	1.00E+00	1.79E-01	4.39E-03
Pesticides					
4,4'-DDD	3.90E-03	1.34E-02	1.00E-01	4.37E-04	2.97E-05
4,4'-DDE	9.20E-03	1.80E-02	2.50E-02	7.99E-04	6.96E-05
4,4'-DDT	8.30E-03	1.00E-02	1.00E-01	9.22E-04	6.31E-05
Endosulfan I	7.50E-03	3.44E-01	2.50E-01	1.92E-03	7.63E-05
Endosulfan sulfate	5.20E-03	2.97E-01	2.50E-01	1.27E-03	5.11E-05
Endrin ketone	9.40E-03	2.20E-02	1.80E-01	1.34E-03	7.32E-05
Metals					
Cadmium	8.30E-01	5.50E-01	2.15E-02	9.22E-02	6.82E-03
Sodium	5.78E+02	1.00E+00	1.00E+00	2.78E+02	5.83E+00

1 SP: soil-to-plant uptake factor.

2 BAF: bioaccumulation factor

3 Exposure calculated as

ED = [(Cs * SP * CF * Ip) + (Cs * BAF * Ia) + (Cs * Is)] * SFF / BW

Where, ED = exposure dose

Cs = maximum or mean concentration in soil (mg/kg)

CF = plant dry-to-wet-weight conversion factor (0.2) for inorganics only

SP = soil-to-plant uptake factor for vegetative matter

Ip = plant-matter intake rate: Robin = 0.0366 kg/day, Dove = 0.00931 kg/day

BAF = invertebrate bioaccumulation factor (unitless)

Ia = animal-matter intake rate: Robin = 0.0466 kg/day, Dove = 0.00164 kg/day

Is = incidental soil intake rate: Robin = 0.00965 kg/day, Dove = 0.00125 kg/day

SFF = Robin = 0.583, Dove = 0.120

BW = body weight: Robin = 0.077 kg, Dove = 0.157 kg

TABLE F-17
CALCULATED SURFACE SOIL/SEDIMENT HAZARD QUOTIENTS - MAMMALS
SEAD-63
Seneca Army Depot Activity

Constituent	Deer Mouse Exposure (mg/kg/day)[1]	Short-tailed Shrew Exposure (mg/kg/day)[1]	Toxicity Reference Value (mg/kg/day)[2]	Deer Mouse Hazard Quotient[3]	Short-tailed Shrew Hazard Quotient[3]
Volatiles					
Acetone	8.70E-01	2.87E-01	1.00E+01	0.09	0.03
Benzene	5.81E-03	2.80E-02	2.64E+01	0.00	0.00
Methyl ethyl ketone	1.07E-01	4.96E-02	1.77E+02	0.00	0.00
Toluene	1.12E-01	5.77E-01	2.60E+01	0.00	0.02
Total Xylenes	9.98E-03	4.80E-02	2.10E+00	0.00	0.02
PAHs					
Benzo(a)anthracene	3.91E-02	1.43E-01	1.00E+00	0.04	0.14
Benzo(a)pyrene	1.62E+00	6.99E+00	1.00E+00	**1.62**	**6.99**
Benzo(b)fluoranthene	1.39E-01	6.37E-01	1.00E+00	0.14	0.64
Benzo(k)fluoranthene	6.11E-02	2.73E-01	1.00E+00	0.06	0.27
Chrysene	5.65E-02	2.20E-01	1.00E+00	0.06	0.22
Dibenz(a,h)anthracene	5.40E-02	2.51E-01	1.00E+00	0.05	0.25
Fluoranthene	4.04E-01	1.94E+00	1.25E+00	0.32	**1.55**
Fluorene	6.46E-03	2.19E-02	1.25E+00	0.01	0.02
Indeno(1,2,3-cd)pyrene	1.25E-01	5.95E-01	1.00E+00	0.12	0.60
2-Methylnaphthalene	8.25E-04	2.79E-03	7.16E+00	0.00	0.00
Naphthalene	2.05E-03	4.79E-03	7.16E+00	0.00	0.00
Phenanthrene	4.29E-02	1.09E-01	1.00E+00	0.04	0.11
Pyrene	6.12E-02	1.72E-01	1.00E+00	0.06	0.17
Semi-volatiles					
Bis(2-ethylhexyl)phthalate	2.34E+00	1.23E+01	1.83E+01	0.13	0.67
Butylbenzylphthalate	1.42E-02	6.84E-02	1.59E+02	0.00	0.00
Carbazole	5.39E+00	2.81E+01	5.00E+00	**1.08**	**5.62**
Dibenzofuran	4.63E-03	2.06E-02	no data	--	--
Diethyl phthalate	1.91E-02	6.33E-02	4.58E+03	0.00	0.00
Di-n-butylphthalate	1.83E-02	8.57E-02	5.50E+02	0.00	0.00
Di-n-octylphthalate	1.01E+01	5.29E+01	1.83E+01	0.55	**2.89**
Phenol	6.47E-02	6.88E-02	no data	--	--
Pesticides					
4,4'-DDD	6.49E-05	2.23E-04	8.00E-01	0.00	0.00
4,4'-DDE	8.32E-05	1.36E-04	8.00E-01	0.00	0.00
4,4'-DDT	1.35E-04	4.74E-04	8.00E-01	0.00	0.00
Endosulfan I	5.14E-04	1.15E-03	5.00E-01	0.00	0.00
Endosulfan sulfate	3.30E-04	7.88E-04	2.50E-01	0.00	0.00
Endrin ketone	2.46E-04	9.68E-04	9.20E-02	0.00	0.01
Metals					
Cadmium	1.54E-02	1.30E-02	1.00E+00	0.02	0.01
Sodium	7.75E+01	3.32E+02	no data	--	--

(1) Receptor exposure from Table I-15

(2) Toxicity reference value from Table A-10

(3) Hazard quotient calculated as HQ = exposure rate / toxicity reference value
with HQ < 1, no effects expected
1 < HQ =< 10, small potential for effects
10 < HQ =< 100, potential for greater exposure to result in effects and
HQ > 100, highest potential for effects

TABLE F-18
CALCULATED SURFACE SOIL/SEDIMENT HAZARD QUOTIENTS - BIRDS
SEAD 63
Seneca Army Depot Activity

Constituent	Robin Max Exposure[1] (mg/kg/day)	Dove Max Exposure[1] (mg/kg/day)	NOAEL Toxicity Reference Value[2] (mg/kg/day)	Robin NOAEL Max Hazard Quotient[3]	Dove NOAEL Max Hazard Quotient[3]
Volatiles					
Acetone	2.25E+00	5.83E-02	6.10E+02	0.00	0.00
Benzene	1.87E-02	1.10E-04	No data	--	--
Methyl ethyl ketone	2.80E-01	7.15E-03	No data	--	--
Toluene	3.64E-01	1.52E-03	No data	--	--
Total Xylenes	3.28E-02	2.66E-04	3.06E+02	0.00	0.00
PAHs					
Benzo(a)anthracene	2.43E-01	1.53E-02	2.85E+01	0.01	0.00
Benzo(a)pyrene	5.24E+00	5.50E-02	2.85E+01	0.18	0.00
Benzo(b)fluoranthene	6.56E-01	2.75E-02	2.85E+01	0.02	0.00
Benzo(k)fluoranthene	3.10E-01	1.47E-02	2.85E+01	0.01	0.00
Chrysene	3.10E-01	1.71E-02	2.85E+01	0.01	0.00
Dibenz(a,h)anthracene	2.46E-01	9.51E-03	2.85E+01	0.01	0.00
Fluoranthene	1.56E+00	3.73E-02	2.85E+01	0.05	0.00
Fluorene	2.62E-02	9.88E-04	2.85E+01	0.00	0.00
Indeno(1,2,3-cd)pyrene	5.53E-01	1.98E-02	2.85E+01	0.02	0.00
2-Methylnaphthalene	3.34E-03	1.26E-04	2.85E+01	0.00	0.00
Naphthalene	7.27E-03	2.53E-04	2.85E+01	0.00	0.00
Phenanthrene	2.17E-01	1.24E-02	2.85E+01	0.01	0.00
Pyrene	3.77E-01	2.51E-02	2.85E+01	0.01	0.00
Semi-volatiles					
Bis(2-ethylhexyl)phthalate	7.75E+00	4.06E-02	1.10E-01	**70**	0.37
Butylbenzylphthalate	5.29E-02	1.09E-03	No data	--	--
Carbazole	1.76E+01	6.86E-02	No data	--	--
Dibenzofuran	1.68E-02	3.50E-04	2.18E-01	0.08	0.00
Diethyl phthalate	3.82E+00	1.47E-02	1.10E-02	**347**	**1.3**
Di-n-butylphthalate	1.82E-02	1.01E-03	1.10E-02	**1.7**	0.09
Di-n-octylphthalate	3.28E+01	1.17E-01	1.10E-02	**2984**	**10.7**
Phenol	1.79E-01	4.39E-03	No data	--	--
Pesticides					
4,4'-DDD	4.37E-04	2.97E-05	5.60E-02	0.01	0.00
4,4'-DDE	7.99E-04	6.96E-05	5.60E-02	0.01	0.00
4,4'-DDT	9.22E-04	6.31E-05	5.60E-02	0.02	0.00
Endosulfan I	1.92E-03	7.63E-05	1.00E+00	0.00	0.00
Endosulfan sulfate	1.27E-03	5.11E-05	1.00E+00	0.00	0.00
Endrin ketone	1.34E-03	7.32E-05	3.00E-01	0.00	0.00
Metals					
Cadmium	9.22E-02	6.82E-03	1.45E+00	0.06	0.00
Sodium	2.78E+02	5.83E+00	No data	--	--

1 Receptor exposure from Table H.30.
2 NOAEL toxicity reference value from Table H.13.
3 Hazard quotient calculated as HQ = exposure rate toxicity reference value
BOLD : represents receptor HQ > 1.

Mammals

Compound	Deer Mouse Hazard Quotient	Shrew Hazard Quotient
Benzo(a)pyrene	**1.6**	**7.0**
Carbazole	**1.1**	**5.6**
Fluoranthene	0.3	**1.6**
Di-n-octylphthalate	0.6	**2.9**

The hazard quotients calculated for the mammalian species are all ascribed to limited zones of shallow soil/sediment contamination as they generally result due to finding elevated concentrations of the chemicals in one or more related samples. Specifically, the hazard quotients calculated for Benzo(a)pyrene, Carbazole, and Fluoranthene initially result from measuring elevated concentrations of each of these species (i.e., 2,700 ug/Kg, 430 ug/Kg, and 4,300 ug/Kg, respectively) at a single location SW/SD63-19. Of further note is the fact that the second highest concentration measured in any shallow soil/sediment sample for each of these compounds is also collocated in a sample collected from SW/SD63-18. Using the next highest measured concentration for each species and repeating the hazard quotient calculation results in the indication that concentrations measured for one of the problematic chemicals (i.e., Fluoranthene) is potentially acceptable, while a reduced hazard quotient is still represented by the other two chemicals for the shrew.

If the third highest measured concentration is then used for the remaining two species (i.e., 540 ug/Kg for benzo(a)pyrene at SW/SD63-4 and 93 ug/kg for carbazole SW/SD63-13), the computed hazard quotients for the shrew are further reduced to 1.4 and 1.2, respectively for the shrew. Of additional note, is the fact that the continuing high carbazole level is found in the location SW/SD63-4 that is downgradient of both SW/SD 63-18 and 19. The computed hazard quotient for all three chemicals and the deer mouse are all less than 1.

If the maximum concentrations measured for the benzo(a)pyrene and the carbazole are set to the fourth highest concentration measured (i.e., 200 ug/Kg and 34 ug/Kg, respectively), the calculated risk posed to the shrew is also eliminated.

With respect to the hazard quotient recorded for Di-n-octylphthalate, this results due the sole sample in which it was detected at a concentration of 19J ug/Kg. This sample was collected at location SWSD63-3, which is north of SEAD-63.

Birds

The HQs computed for four phthalate species based on the maximum observed concentration in shallow soil/sediment samples indicate that site contaminants represent a potential threat to the American Robin and/or the Mourning Dove. A summary of this data is presented below:

Compound	**American Robin Hazard Quotient**	**Mourning Dove Hazard Quotient**
Bis(2-ethylhexyl)phthalate	**70**	0.37
Diethyl phthalate	**347**	**1.3**
Di-n-butylphthalate	**1.7**	0.09
Di-n-octylphthalate	**2984**	**10.7**

Bis(2-ethylhexyl)phthalate was found in 17 of 27 shallow soil/sediment samples collected from SEAD-63. Measured concentrations ranged from a minimum of 8.3 to a maximum of 1,800 ug/Kg. Based on the indices used for the determination for the robin, the maximum concentration that could be measured to ensure that no risk was present for the robin would be 26 ug/Kg. Seven of the 17 samples that contained Bis2-ethylhexyl)phthalate exhibit concentrations that were higher than this level. These samples are all generally located in the vicinity of the former burial area.

Diethyl phthalate was detected in 9 of 22 shallow soil/sediment samples collected from the area of SEAD-63. Measured concentrations ranged from a low of 4.7 to a high of 92 ug/Kg. All of the measured concentrations would represent a potential threat to the American Robin, while any concentration in excess of 70 ug/Kg would suggest a potential threat to the Mourning Dove. The identified Diethyl phthalate is all located in drainage ditches that surrounds the former burial area.

Di-n-butylphthalate was detected in 7 of the 27 shallow soil/sediment samples collected from the area of SEAD-63. Measured concentrations ranged from a low of 6.5 to a high of 120 ug/Kg. The second highest concentration measured in any shallow soil/sediment sample was 19 ug/Kg, and at this concentration the hazard quotient calculated for the robin would drop to 0.28. This suggests that the presumed risk associated with this compound is restricted to a hotspot that is near SWSD63-14..

Di-n-octylphthalate was detected in 1 of the 22 shallow soil/sediment samples collected from the area of SEAD-63. The only measured concentration found for this compound was 19J. This suggests that the apparent risk posed to both the robin and dove is associated with a hot spot that is located at SWSD63-3, as is noted above for the mouse and shrew.

F.6.4.1 Uncertainty

Uncertainty is inherent in each step of the ecological risk assessment process. Major factors contributing to uncertainty in this risk assessment are discussed qualitatively in the following sections.

Chemicals of Potential Concern

The sampling data may not represent the actual overall distribution of contamination at the site, which could result in underestimation or overestimation of potential risk from identified chemicals. However, the use of maximum concentrations provided conservative exposure estimates and it is, therefore, unlikely that the potential for deleterious levels of contaminants has been underestimated.

Exposure Assessment

While the potential receptor species selected for the site are inevitably a limited subset of the total list of species that may utilize the site, the potential exposure of the species evaluated in this assessment is considered likely to be representative of the nature and magnitude of the exposures experienced by those species not discussed.

Risk associated with intake of contaminants through the terrestrial food chain was addressed by modeling food chain transfer of chemical residues through plants and earthworms. The degree of uncertainty in the results of the analysis increases with the increasing distance of the receptor from the base of the food chain. Intakes from dermal contact with and inhalation of contaminants were not quantifiable for ecological receptors. However, this does not significantly increase the uncertainty of the estimated intakes because for most receptors, intakes via these routes are likely to be minimal relative to intakes via ingestion.

Toxicity Assessment

There is uncertainty associated with the TRVs calculated for this risk characterization because the toxicity data were not site-specific. However, the TRVs used were conservative and were modified by uncertainty factors where necessary to increase the applicability of the data to the assessment. The HQs calculated from these conservative TRVs and maximum concentrations provide confidence that the risk assessment yielded reasonably conservative estimates of the potential risk of adverse ecological effects on the assessment endpoint.

Each COPC was assumed to be highly bioavailable. However, for most chemicals in most media, this is an overestimation (Dixon et al., 1993) that may result in an overestimation of the potential for ecological risk. Empirical information on bioavailability of the COPCs was not available. No leachability tests in soil or sediment were conducted. No analysis for acid-volatile sulfide/simultaneously extracted metals was conducted as a measure of bioavailability in sediment. It is possible that some of the contaminants, particularly the metals, may be bound to soil or sediment particles and not available for uptake by receptors. This would tend to overestimate risk.

The soil-to-plant uptake equations and the BAFs include a bioavailability factor; however, these data, taken from the scientific literature, are not specific to this site and may under- or overestimate exposure. For several metals, no quantitative bioavailability data could be found, other than an indication from the literature that the constituent does not significantly bioaccumulate. For these metals, a bioaccumulation factor of 1.0 was used in the exposure equation. This is likely to overestimate the actual value.

The potential for toxic effects to be produced in receptor organisms as a result of exposure to multiple chemicals in a single medium or in multiple media was not evaluated. Therefore, the potential toxic effects in a receptor as a result of exposure to a given medium could be higher or lower than estimated, depending on toxicological interactions. Exposure of a receptor to multiple contaminated media is likely to increase the risk of toxic effects.

Risk Characterization

The methodology, conservative assumptions, and toxicity benchmarks used in the risk estimation portion of the risk characterization are expected to overestimate, rather than underestimate, the potential for COPCs to pose risk to the ecological assessment endpoint. Maximum environmental concentrations were used, concentrations were assumed to remain constant over time, and the toxicity benchmarks used were the NOAEL values (levels where no toxic effects are expected) or conservative surrogates based on LOAEL values for non-lethal or reproductive effects appropriate for extrapolation to effects on the assessment endpoint.

F.6.4.2 Ecological Risk Summary

COPCs in soil were quantitatively assessed for ecological risk for future conditions. These COPCs include contaminants estimated to have the potential to pose adverse effects to the selected assessment endpoints. Exposure to these COPCs by representative terrestrial receptors (deer mouse, American robin, mourning dove, and short-tailed shrew) was further evaluated to determine if any COPCs have a high likelihood of being a risk to the receptor population analyzed for this risk assessment or the ecological community that encompasses the study area.

A hierarchy of assessment endpoints was selected to assess both proximate and ultimate risks that might be associated with site-related chemicals. The proximate assessment endpoint was chosen to provide protection of the population levels of vertebrate species that utilize the sites to a significant extent and that are important as indicators of potential effects on the health of the community. Deer mice and short-tailed shrews represent terrestrial vertebrate populations at the sites. The American robin and mourning dove represent avian populations that usually remain close to or on the surface of the soil and come in contact with it quite frequently. Although toxic effects that reduce this assessment endpoint population or the populations they represent in the immediate vicinity of the site are significant to the populations themselves, they are not necessarily significant to the ultimate, more important, assessment endpoint: the community of species that occupies the area surrounding and including the site.

It is this ultimate assessment endpoint, maintenance of the health and diversity of the natural community in the area, that is the most important ecological component to be protected with regard to this site. Therefore, any COCs estimated to pose a potential for adverse effects to proximate assessment endpoints would subsequently be evaluated with regard to the risk they may pose to the ultimate assessment endpoint.

The ecological setting of the site is not unique or significant, as described in **Section F.6.2.2.** There are no endangered, threatened, or special concern species in the vicinity that are likely to be dependent on or affected by the habitat at the site. The species that inhabit the site are not rare in the region and are not generally considered to be of special societal value. The habitat in the site appears to be relatively low in diversity and productivity.

In soils available to terrestrial receptors (0-2-ft. depth), representative of future conditions at the site, HQs calculated for seven semivolatile organic compounds indicate that potential risks may exist for selected mammalian and avian species. Closer review of these data indicates that the posed threats may be isolated to hot spots that required closer examination during the proposed removal action.

TABLE A-1
CALCULATION OF INTAKE AND RISK FROM INHALATION OF DUST IN AMBIENT AIR
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

<u>Variables (Assumptions for Each Receptor are Listed at the Bottom)</u>

CA = Chemical Concentration in Air, Calculated from Air EPC Data
IR = Inhalation Rate
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Inhalation RfD (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Air EPC* from Surface Soil (mg/m3)	Air EPC* from Total Soils (mg/m3)	Park Worker				Recreational Visitor (Child)				Construction Worker			
					Intake (mg/kg-day) (Nc)	Intake (mg/kg-day) (Car)	Hazard Quotient	Cancer Risk	Intake (mg/kg-day) (Nc)	Intake (mg/kg-day) (Car)	Hazard Quotient	Cancer Risk	Intake (mg/kg-day) (Nc)	Intake (mg/kg-day) (Car)	Hazard Quotient	Cancer Risk
Volatile Organics																
Acetone	NA	NA		2.37E-008												
2-Butanone	2.86E-001	NA		6.81E-009									6.93E-010		2E-009	
Benzene	1.71E-003	2.73E-002	3.40E-011	5.92E-010	1.86E-012	6.65E-013	1E-009	2E-014	4.21E-012	3.01E-013	2E-009	8E-015	6.02E-011	8.61E-013	4E-008	2E-014
Toluene	1.14E-001	NA	1.02E-010	3.40E-009	5.59E-012		5E-011		1.26E-011		1E-010		3.46E-010		3E-009	
Total Xylenes	NA	NA	2.38E-010	2.07E-009												
Semivolatile Organics																
Benzo(a)anthracene	NA	NA		4.44E-009												
Benzo(a)pyrene	NA	NA	4.08E-010	6.66E-009												
Benzo(b)fluoranthene	NA	NA	3.57E-010	5.62E-009												
Benzo(ghi)perylene	NA	NA		4.59E-009												
Benzo(k)fluoranthene	NA	NA	3.57E-010	6.36E-009												
bis(2-Ethylhexyl)phthalate	NA	NA	3.06E-008	2.66E-007												
Chrysene	NA	NA	3.91E-010	4.59E-009												
Dibenz(a,h)anthracene	NA	NA		4.14E-009												
Di-n-butylphthalate	NA	NA		1.29E-008												
Fluoranthene	NA	NA	6.46E-010	9.32E-009												
Indeno(1,2,3-cd)pyrene	NA	NA		5.48E-009												
Phenanthrene	NA	NA		4.59E-009												
Pesticides/PCBs																
4,4'-DDD	NA	NA		2.96E-010												
4,4'-DDE	NA	NA		6.51E-010												
4,4'-DDT	NA	3.40E-001		4.88E-010										7.10E-013		2E-013
Metals																
Cadmium	NA	6.30E+000	9.52E-009	3.55E-006		1.86E-010		1E-009		8.43E-011		5E-010		5.16E-009		3E-008
Mercury	8.57E-005	NA	1.02E-009	7.25E-008	5.59E-011		7E-007		1.26E-010		1E-006		7.38E-009		9E-005	
Total Hazard Quotient and Cancer Risk:							**7E-007**	**1E-009**			**1E-006**	**5E-010**			**9E-005**	**3E-008**

Assumptions for Park Worker
CA = EPC Surface Only
BW = 70 kg
IR = 8 m3/day
EF = 175 days/year
ED = 25 years
AT (Nc) = 9,125 days
AT (Car) = 25,550 days

Assumptions for Recreational Visitor (Child)
CA = EPC Surface Only
BW = 15 kg
IR = 8.7 m3/day
EF = 78 days/year
ED = 5 years
AT (Nc) = 1,825 days
AT (Car) = 25,550 days

Assumptions for Construction Worker
CA = EPC Surface and Sub-Surface
BW = 70 kg
IR = 10.4 m3/day
EF = 250 days/year
ED = 1 year
AT (Nc) = 365 days
AT (Car) = 25,550 days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
* See Table A-3 for calculation of Air EPC
NA: Information not available

TABLE-2
CALCULATION OF INTAKE AND RISK FROM INHALATION OF DUST IN AMBIENT AIR
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA Mini Risk Assessment
Seneca Army Depot Activity

$$\text{Equation for Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables (Assumptions for Each Receptor are Listed at the Bottom)

CA = Chemical Concentration in Air, Calculated from Air EPC Data
IR = Inhalation Rate
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Contribution to Lifetime Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Inhalation RfD (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Air EPC* from Surface Soil (mg/m3)	Resident (Adult) Intake (mg/kg-day) (Nc)	Resident (Adult) Intake (mg/kg-day) (Car)	Resident (Adult) Hazard Quotient	Resident (Adult) Contribution to Lifetime Cancer Risk	Resident (Child) Intake (mg/kg-day) (Nc)	Resident (Child) Intake (mg/kg-day) (Car)	Resident (Child) Hazard Quotient	Resident (Child) Contribution to Lifetime Cancer Risk	Resident Total Lifetime Cancer Risk
Volatile Organics												
Acetone	NA	NA										
2-Butanone	2.86E-001	NA										
Benzene	1.71E-003	2.73E-002	3.40E-011	9.32E-012	3.19E-012	5E-009	9E-014	1.89E-011	1.62E-012	1E-008	4E-014	1E-013
Toluene	1.14E-001	NA	1.02E-010	2.79E-011		2E-010		5.67E-011		5E-010		
Total Xylenes	NA	NA	2.38E-010									
Semivolatile Organics												
Benzo(a)anthracene	NA	NA										
Benzo(a)pyrene	NA	NA	4.08E-010									
Benzo(b)fluoranthene	NA	NA	3.57E-010									
Benzo(ghi)perylene	NA	NA										
Benzo(k)fluoranthene	NA	NA	3.57E-010									
bis(2-Ethylhexyl)phthalate	NA	NA	3.06E-008									
Chrysene	NA	NA	3.91E-010									
Dibenz(a,h)anthracene	NA	NA										
Di-n-butylphthalate	NA	NA										
Fluoranthene	NA	NA	6.46E-010									
Indeno(1,2,3-cd)pyrene	NA	NA										
Phenanthrene	NA	NA										
Pesticides/PCBs												
4,4'-DDD	NA	NA										
4,4'-DDE	NA	NA										
4,4'-DDT	NA	3.40E-001										
Metals												
Cadmium	NA	6.30E+000	9.52E-009		8.94E-010		6E-009		4.54E-010		3E-009	8E-009
Mercury	8.57E-005	NA	1.02E-009	2.79E-010		3E-006		5.67E-010		7E-006		
Total Hazard Quotient and Cancer Risk:						**3E-006**				**7E-006**		**8E-009**

Assumptions for Resident (Adult)

CA =	EPC Surface Only	
BW =	70	kg
IR =	20	m3/day
EF =	350	days/year
ED =	24	years
AT (Nc) =	8,760	days
AT (Car) =	25,550	days

Assumptions for Resident (Child)

CA =	EPC Surface Only	
BW =	15	kg
IR =	8.7	m3/day
EF =	350	days/year
ED =	6	years
AT (Nc) =	2,190	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
* See Table A-3 for calculation of Air EPC
NA= Information not available

TABLE A-3
AMBIENT AIR EXPOSURE POINT CONCENTRATIONS - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Air EPC from Surface Soil (mg/m^3) = CS dsurf x PM d10 x CF	Equation for Air EPC from Total Soils (mg/m^3) = CS dtot x PM d10 x CF
Variables	Variables
CS dsurf = Chemical Concentration in Surface Soil, from EPC data (mg/kg)	CS dtot = Chemical Concentration in Total Soils, from EPC data (mg/kg)
PM d10 = Average Measured PM d10 Concentration = 17 ug/m^3	PM d10 = PM d10 Concentration Calculated for Construction Worker= 148 ug/m^3
CF = Conversion Factor = 1E-9 kg/ug	CF = Conversion Factor = 1E-9 kg/ug

Analyte	EPC Data for Surface Soil (mg/kg)	EPC Data for Total Soils (mg/kg)	Calculated Air EPC Surface Soil (mg/m^3)	Calculated Air EPC Total Soils (mg/m^3)
Volatile Organics				
Acetone		1.60E-001		2.37E-008
2-Butanone		4.60E-002		6.81E-009
Benzene	2.00E-003	4.00E-003	3.40E-011	5.92E-010
Toluene	6.00E-003	2.30E-002	1.02E-010	3.40E-009
Total Xylenes	1.40E-002	1.40E-002	2.38E-010	2.07E-009
Semivolatile Organics				
Benzo(a)anthracene		3.00E-002		4.44E-009
Benzo(a)pyrene	2.40E-002	4.50E-002	4.08E-010	6.66E-009
Benzo(b)fluoranthene	2.10E-002	3.80E-002	3.57E-010	5.62E-009
Benzo(ghi)perylene		3.10E-002		4.59E-009
Benzo(k)fluoranthene	2.10E-002	4.30E-002	3.57E-010	6.36E-009
bis(2-Ethylhexyl)phthalate	1.80E+000	1.80E+000	3.06E-008	2.66E-007
Chrysene	2.30E-002	3.10E-002	3.91E-010	4.59E-009
Dibenz(a,h)anthracene		2.80E-002		4.14E-009
Di-n-butylphthalate		8.70E-002		1.29E-008
Fluoranthene	3.80E-002	6.30E-002	6.46E-010	9.32E-009
Indeno(1,2,3-cd)pyrene		3.70E-002		5.48E-009
Phenanthrene		3.10E-002		4.59E-009
Pesticides/PCBs				
4,4'-DDD		2.00E-003		2.96E-010
4,4'-DDE		4.40E-003		6.51E-010
4,4'-DDT		3.30E-003		4.88E-010
Metals				
Cadmium	5.60E-001	2.40E-001	9.52E-009	3.55E-006
Mercury	6.00E-002	4.90E-001	1.02E-009	7.25E-008

ND = Compound was not detected.

TABLE A-4
CALCULATION OF INTAKE AND RISK FROM THE INGESTION OF SOIL
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom):
CS = Chemical Concentration in Soil, Calculated from Soil EPC Data
IR = Ingestion Rate
CF = Conversion Factor
FI = Fraction Ingested
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Oral RfD (mg/kg-day)	Carc. Slope Oral (mg/kg-day)-1	EPC Surface Soil (mg/kg)	EPC from Total Soils (mg/kg)	Park Worker				Recreational Visitor (Child)				Construction Worker			
					Intake (mg/kg-day) (Nc)	Intake (mg/kg-day) (Car)	Hazard Quotient	Cancer Risk	Intake (mg/kg-day) (Nc)	Intake (mg/kg-day) (Car)	Hazard Quotient	Cancer Risk	Intake (mg/kg-day) (Nc)	Intake (mg/kg-day) (Car)	Hazard Quotient	Cancer Risk
Volatile Organics																
Acetone	1 00E-001	NA		1 60E-001									7 51E-007		8E-006	
2-Butanone	6 00E-001	NA		4 60E-002									2 16E-007		4E-007	
Benzene	3 00E-003	2 90E-002	2 00E-003	4 00E-003	1 37E-009	4 89E-010	5E-007	1E-011	5 70E-009	4 07E-010	2E-006	1E-011	1 88E-008	2 68E-010	6E-006	8E-012
Toluene	2 00E-001	NA	6 00E-003	2 30E-002	4 11E-009		2E-008		1 71E-008		9E-008		1 08E-007		5E-007	
Total Xylenes	2 00E+000	NA	1 40E-002	1 40E-002	9 59E-009		5E-009		3 99E-008		2E-008		6 58E-008		3E-008	
Semivolatile Organics																
Benzo(a)anthracene	NA	7 30E-001		3 00E-002										2 01E-009		1E-009
Benzo(a)pyrene	NA	7 30E+000	2 40E-002	4 50E-002		5 87E-009		4E-008		4 88E-009		4E-008		3 02E-009		2E-008
Benzo(b)fluoranthene	NA	7 30E-001	2 10E-002	3 80E-002		5 14E-009		4E-009		4 27E-009		3E-009		2 55E-009		2E-009
Benzo(ghi)perylene	NA	NA		3 10E-002												
Benzo(k)fluoranthene	NA	7 30E-002	2 10E-002	4 30E-002		5 14E-009		4E-010		4 27E-009		3E-010		2 89E-009		2E-010
bis(2-Ethylhexyl)phthalate	2 00E-002	1 40E-002	1 80E+000	1 80E+000	1 23E-006	4 40E-007	6E-005	6E-009	5 13E-006	3 66E-007	3E-004	5E-009	8 45E-006	1.21E-007	4E-004	2E-009
Chrysene	NA	7 30E-003	2 30E-002	3 10E-002		5 63E-009		4E-011		4 68E-009		3E-011		2 08E-009		2E-011
Dibenz(a,h)anthracene	NA	7 30E+000		2 80E-002										1 88E-009		1E-008
Di-n-butylphthalate	1 00E-001	NA		8 70E-002									4 09E-007		4E-006	
Fluoranthene	4 00E-002	NA	3 80E-002	6 30E-002	2 60E-008		7E-007		1 08E-007		3E-006		2 96E-007		7E-006	
Indeno(1,2,3-cd)pyrene	NA	7.30E-001		3 70E-002										2 48E-009		2E-009
Phenanthrene	NA	NA		3 10E-002												
Pesticides/PCBs																
4,4'-DDD	NA	2 40E-001		2 00E-003										1 34E-010		3E-011
4,4'-DDE	NA	3.40E-001		4 40E-003										2 95E-010		1E-010
4,4'-DDT	5 00E-004	3 40E-001		3 30E-003									1 55E-008	2 21E-010	3E-005	8E-011
Metals																
Cadmium	5.00E-004	NA	5 60E-001	2 40E+001	3 84E-007		8E-004		1 60E-006		3E-003		1 13E-004		2E-001	
Mercury	3.00E-004	NA	6.00E-002	4 90E-001	4 11E-008		1E-004		1 71E-007		6E-004		2 30E-006		8E-003	
Total Hazard Quotient and Cancer Risk:							**1E-003**	**5E-008**			**4E-003**	**4E-008**			**2E-001**	**4E-008**

Assumptions for Park Worker

CF =	1E-006	kg/mg
CS =	EPC Surface Only	
BW =	70	kg
IR =	100	mg soil/day
FI =	1	unitless
EF =	175	days/year
ED =	25	years
AT (Nc) =	9,125	days
AT (Car) =	25,550	days

Assumptions for Recreational Visitor (Child)

CF =	1E-006	kg/mg
CS =	EPC Surface Only	
BW =	15	kg
IR =	200	mg soil/day
FI =	1	unitless
EF =	78	days/year
ED =	5	years
AT (Nc) =	1,825	days
AT (Car) =	25,550	days

Assumptions for Construction Worker

CF =	1E-006	kg/mg
CS =	EPC Surface and Subsurface	
BW =	70	kg
IR =	480	mg soil/day
FI =	1	unitless
EF =	250	days/year
ED =	1	years
AT (Nc) =	365	days
AT (Car) =	25,550	days

Note Cells in this table were intentionally left blank due to a lack of toxicity data
NA= Information not available.

TABLE 5
CALCULATION OF INTAKE AND RISK FROM THE INGESTION OF SOIL
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom)
CS = Chemical Concentration in Soil, Calculated from Soil EPC Data
IR = Ingestion Rate
CF = Conversion Factor
FI = Fraction Ingested
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Oral RfD (mg/kg-day)	Carc. Slope Oral (mg/kg-day)-1	EPC Surface Soil (mg/kg)	Resident (Adult) Intake (mg/kg-day) (Nc)	Resident (Adult) Intake (mg/kg-day) (Car)	Resident (Adult) Hazard Quotient	Resident (Adult) Contribution to Lifetime Cancer Risk	Resident (Child) Intake (mg/kg-day) (Nc)	Resident (Child) Intake (mg/kg-day) (Car)	Resident (Child) Hazard Quotient	Resident (Child) Contribution to Lifetime Cancer Risk	Resident Total Lifetime Cancer Risk
Volatile Organics												
Acetone	1.00E-001	NA										
2-Butanone	6.00E-001	NA										
Benzene	3.00E-003	2.90E-002	2.00E-003	2.74E-009	9.39E-010	9E-007	3E-011	2.56E-008	2.19E-009	9E-006	6E-011	9E-011
Toluene	2.00E-001	NA	6.00E-003	8.22E-009		4E-008		7.67E-008		4E-007		
Total Xylenes	2.00E+000	NA	1.40E-002	1.92E-008		1E-008		1.79E-007		9E-008		
Semivolatile Organics												
Benzo(a)anthracene	NA	7.30E-001										
Benzo(a)pyrene	NA	7.30E+000	2.40E-002		1.13E-008		8E-008		2.63E-008		2E-007	3E-007
Benzo(b)fluoranthene	NA	7.30E-001	2.10E-002		9.86E-009		7E-009		2.10E-008		2E-008	2E-008
Benzo(ghi)perylene	NA	NA										
Benzo(k)fluoranthene	NA	7.30E-002	2.10E-002		9.86E-009		7E-010		2.10E-008		2E-009	2E-009
bis(2-Ethylhexyl)phthalate	2.00E-002	1.40E-002	1.80E+000	2.47E-006	8.45E-007	1E-004	1E-008	2.30E-005	1.97E-006	1E-003	3E-008	4E-008
Chrysene	NA	7.30E-003	2.30E-002		1.08E-008		8E-011		2.52E-008		2E-010	3E-010
Dibenz(a,h)anthracene	NA	7.30E+000										
Di-n-butylphthalate	1.00E-001	NA										
Fluoranthene	4.00E-002	NA	3.80E-002	5.21E-008		1E-006		4.86E-007		1E-005		
Indeno(1,2,3-cd)pyrene	NA	7.30E-001										
Phenanthrene	NA	NA										
Pesticides/PCBs												
4,4'-DDD	NA	2.40E-001										
4,4'-DDE	NA	3.40E-001										
4,4'-DDT	5.00E-004	3.40E-001										
Metals												
Cadmium	5.00E-004	NA	5.60E-001	7.67E-007		2E-003		7.16E-006		1E-002		
Mercury	3.00E-004	NA	6.00E-002	8.22E-008		3E-004		7.67E-007		3E-003		
Total Hazard Quotient and Cancer Risk:						**2E-003**				**2E-002**		**3E-007**

Assumptions for Resident (Adult)
CF = 1E-006 kg/mg
CS = EPC Surface Only
BW = 70 kg
IR = 100 mg soil/day
FI = 1 unitless
EF = 350 days/year
ED = 24 years
AT (Nc) = 8,760 days
AT (Car) = 25,550 days

Assumptions for Resident (Child)
CF = 1E-006 kg/mg
CS = EPC Surface Only
BW = 15 kg
IR = 200 mg soil/day
FI = 1 unitless
EF = 350 days/year
ED = 6 years
AT (Nc) = 2,190 days
AT (Car) = 25,550 days

Note Cells in this table were intentionally left blank due to a lack of toxicity data
NA= Information not available

TABLE A-6
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SOIL
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom):

CS = Chemical Concentration in Soil, from Soil EPC Data
CF = Conversion Factor
SA = Surface Area Contact
AF = Adherence Factor
ABS = Absorption Factor
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Absorption Factor* (unitless)	EPC Surface Soil (mg/kg)	EPC from Total Soils (mg/kg)	Park Worker Absorbed Dose (mg/kg-day) (Nc)	Park Worker Absorbed Dose (mg/kg-day) (Car)	Park Worker Hazard Quotient	Park Worker Cancer Risk	Recreational Visitor (Child) Absorbed Dose (mg/kg-day) (Nc)	Recreational Visitor (Child) Absorbed Dose (mg/kg-day) (Car)	Recreational Visitor (Child) Hazard Quotient	Recreational Visitor (Child) Cancer Risk	Construction Worker Absorbed Dose (mg/kg-day) (Nc)	Construction Worker Absorbed Dose (mg/kg-day) (Car)	Construction Worker Hazard Quotient	Construction Worker Cancer Risk
Volatile Organics																	
Acetone	1.00E-001	NA	NA		1.60E-001												
2-Butanone	6.00E-001	NA	NA		4.60E-002												
Benzene	3.00E-003	2.90E-002	NA	2.00E-003	4.00E-003												
Toluene	2.00E-001	NA	NA	6.00E-003	2.30E-002												
Total Xylenes	2.00E+000	NA	NA	1.40E-002	1.40E-002												
Semivolatile Organics																	
Benzo(a)anthracene	NA	7.3E-001	0.13		3.00E-002										5.40E-010		3.9E-010
Benzo(a)pyrene	NA	7.3E+000	0.13	2.40E-002	4.50E-002		8.70E-009		6.4E-008		1.78E-009		1.3E-008		8.10E-010		5.9E-009
Benzo(b)fluoranthene	NA	7.3E-001	0.13	2.10E-002	3.80E-002		7.61E-009		5.6E-009		1.56E-009		1.1E-009		6.84E-010		5.0E-010
Benzo(ghi)perylene	NA	NA	0.13		3.10E-002												
Benzo(k)fluoranthene	NA	7.3E-002	0.13	2.10E-002	4.30E-002		7.61E-009		5.6E-010		1.56E-009		1.1E-010		7.74E-010		5.6E-011
bis(2-Ethylhexyl)phthalate	2.00E-002	1.4E-002	0.1	1.80E+000	1.80E+000	1.41E-006	5.02E-007	7.0E-005	7.0E-009	1.44E-006	1.03E-007	7.2E-005	1.4E-009	1.74E-006	2.49E-008	8.7E-005	3.5E-010
Chrysene	NA	7.3E-003	0.13	2.30E-002	3.10E-002		8.34E-009		6.1E-011		1.70E-009		1.2E-011		5.58E-010		4.1E-012
Dibenz(a,h)anthracene	NA	7.3E+000	0.13		2.80E-002										5.04E-010		3.7E-009
Di-n-butylphthalate	1.00E-001	NA	0.1		8.70E-002									8.43E-008		8.4E-007	
Fluoranthene	4.00E-002	NA	0.13	3.80E-002	6.30E-002	3.86E-008		9.6E-007		3.94E-008		9.9E-007		7.93E-008		2.0E-006	
Indeno(1,2,3-cd)pyrene	NA	7.3E-001	0.13		3.70E-002										6.66E-010		4.9E-010
Phenanthrene	NA	NA	0.13		3.10E-002												
Pesticides/PCBs																	
4,4'-DDD	NA	2.40E-001	0.03		2.00E-003										8.30E-012		2.0E-012
4,4'-DDE	NA	3.40E-001	0.03		4.40E-003										1.83E-011		6.2E-012
4,4'-DDT	5.00E-004	3.40E-001	0.03		3.30E-003									9.59E-010	1.37E-011	1.9E-006	4.7E-012
Metals																	
Cadmium	1.25E-005	NA	0.001	5.60E-001	2.40E+001	4.37E-009		3.5E-004		4.47E-009		3.6E-004		2.32E-007		1.9E-002	
Mercury	2.10E-005	NA	NA	6.00E-002	4.90E-001												
Total Hazard Quotient and Cancer Risk:								**4E-004**	**8E-008**			**4E-004**	**2E-008**			**2E-002**	**1E-008**

Assumptions for Park Worker

CS =	EPC Surface Only	
CF =	1.00E-006	kg/mg
SA =	5,700	cm2
AF =	0.2	mg/cm2
EF =	175	days/year
ED =	25	years
BW =	70	kg
AT (Nc) =	9,125	days
AT (Car) =	25,550	days

Assumptions for Recreational Visitor (Child)

CS =	EPC Surface Only	
CF =	1.00E-006	kg/mg
SA =	2,800	cm2
AF =	0.2	mg/cm2
EF =	78	days/year
ED =	5	years
BW =	15	kg
AT (Nc) =	1,825	days
AT (Car) =	25,550	days

Assumptions for Construction Worker

CS =	EPC Surface and Subsurface	
CF =	1.00E-006	kg/mg
SA =	3,300	cm2
AF =	0.3	mg/cm2
EF =	250	days/year
ED =	1	years
BW =	70	kg
AT (Nc) =	365	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data

NA= Information not available.

* Recommended dermal absorption factor by EPA Dermal Risk Assessment Guidance (1999)

TABLE A-7
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SOIL
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

$$\text{Equation for Intake (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables (Assumptions for Each Receptor are Listed at the Bottom).

CS = Chemical Concentration in Soil, from Soil EPC Data
CF = Conversion Factor
SA = Surface Area Contact
AF = Adherence Factor
ABS = Absorption Factor
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Contribution to Lifetime Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Absorption Factor* (unitless)	EPC Surface Soil (mg/kg)	Resident (Adult) Intake (mg/kg-day) (Nc)	Resident (Adult) Intake (mg/kg-day) (Car)	Resident (Adult) Hazard Quotient	Resident (Adult) Contribution to Lifetime Cancer Risk	Resident (Child) Intake (mg/kg-day) (Nc)	Resident (Child) Intake (mg/kg-day) (Car)	Resident (Child) Hazard Quotient	Resident (Child) Contribution to Lifetime Cancer Risk	Resident Total Lifetime Cancer Risk
Volatile Organics													
Acetone	1.00E-001	NA	NA										
2-Butanone	6.00E-001	NA	NA										
Benzene	3.00E-003	2.90E-002	NA	2.00E-003									
Toluene	2.00E-001	NA	NA	6.00E-003									
Total Xylenes	2.00E+000	NA	NA	1.40E-002									
Semivolatile Organics													
Benzo(a)anthracene	NA	7.30E-001	0.13										
Benzo(a)pyrene	NA	7.30E+000	0.13	2.40E-002		5.85E-009		4.27E-008		9.57E-009		6.99E-008	1E-007
Benzo(b)fluoranthene	NA	7.30E-001	0.13	2.10E-002		5.12E-009		3.73E-009		8.38E-009		6.12E-009	1E-008
Benzo(ghi)perylene	NA	NA	0.13										
Benzo(k)fluoranthene	NA	7.30E-002	0.13	2.10E-002		5.12E-009		3.73E-010		8.38E-009		6.12E-010	1E-009
bis(2-Ethylhexyl)phthalate	2.00E-002	1.40E-002	0.10	1.80E+000	9.84E-007	3.37E-007	4.92E-005	4.72E-009	6.44E-006	5.52E-007	3.22E-004	7.73E-009	1E-008
Chrysene	NA	7.30E-003	0.13	2.30E-002		5.60E-009		4.09E-011		9.17E-009		6.70E-011	1E-010
Dibenz(a,h)anthracene	NA	7.30E+000	0.13										
Di-n-butylphthalate	1.00E-001	NA	0.10										
Fluoranthene	4.00E-002	NA	0.13	3.80E-002	2.70E-008		6.75E-007		1.77E-007		4.42E-006		
Indeno(1,2,3-cd)pyrene	NA	7.30E-001	0.13										
Phenanthrene	NA	NA	0.13										
Pesticides/PCBs													
4,4'-DDD	NA	2.40E-001	0.03										
4,4'-DDE	NA	3.40E-001	0.03										
4,4'-DDT	5.00E-004	3.40E-001	0.03										
Metals													
Cadmium	1.25E-005	NA	0.00	5.60E-001	3.06E-009		2.45E-004		2.00E-008		1.60E-003		
Mercury	2.10E-005	NA	NA	6.00E-002									
Total Hazard Quotient and Cancer Risk:							**3E-004**	**5E-009**			**2E-003**	**8E-009**	**1E-008**

Assumptions for Resident (Adult)

CS = EPC Surface Only
CF = 1E-006 kg/mg
SA = 5,700 cm2
AF = 0.07 mg/cm2
EF = 350 days/year
ED = 24 years
BW = 70 kg
AT (Nc) = 8,760 days
AT (Car) = 25,550 days

Assumptions for Resident (Child)

CS = EPC Surface Only
CF = 1E-006 kg/mg
SA = 2,800 cm2
AF = 0.2 mg/cm2
EF = 350 days/year
ED = 6 years
BW = 15 kg
AT (Nc) = 2,190 days
AT (Car) = 25,550 days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
NA = Information not available
* Recommended dermal absorption factor by EPA Dermal Risk Assessment Guidance (1999)

TABLE A-8
CALCULATION OF INTAKE AND RISK FROM INHALATION OF GROUNDWATER (WHILE SHOWERING)
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
Decision Document - Mini Risk Assessment
Seneca Army Depot Activity

Based on a lack of toxicity data (i.e. inhalation RfDs and carcinogenic slope factors for the analytes detected) risks from this pathway were not quantified.

TABLE A-9
CALCULATION OF INTAKE AND RISK FROM THE INGESTION OF GROUNDWATER
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CW \times IR \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom):
CW = Chemical Concentration in Groundwater, from Groundwater EPC Data
IR = Ingestion Rate
EF = Exposure Frequency
ED=Exposure Duration
BW - Bodyweight
AT=Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Oral RfD (mg/kg-day)	Carc. Slope Oral (mg/kg-day)-1	EPC Groundwater (mg/liter)	Park Worker Intake (mg/kg-day) (Nc)	Park Worker Intake (mg/kg-day) (Car)	Park Worker Hazard Quotient	Park Worker Cancer Risk	Recreational Visitor (Child) Intake (mg/kg-day) (Nc)	Recreational Visitor (Child) Intake (mg/kg-day) (Car)	Recreational Visitor (Child) Hazard Quotient	Recreational Visitor (Child) Cancer Risk	Construction Worker Intake (mg/kg-day) (Nc)	Construction Worker Intake (mg/kg-day) (Car)	Construction Worker Hazard Quotient	Construction Worker Cancer Risk
Semivolatile Organics															
Phenol	6.00E-001	NA	2.00E-003	1 37E-005		2E-005		2 85E-005		5E-005		Ingestion of Groundwater Not Applicable for Construction Worker			
Metals															
Manganese	5.00E-002	NA	1.07E+000	7 33E-003		1E-001		1.52E-002		3E-001					
Sodium	NA	NA	1 46E+002												
Total Hazard Quotient and Cancer Risk:						**1E-001**				**3E-001**					

Assumptions for Park Worker

BW =	70	kg
IR =	1	liter/day
EF =	175	days/year
ED =	25	years
AT (Nc) =	9,125	days
AT (Car) =	25,550	days

Assumptions for Recreational Visitor (Child)

BW =	15	kg
IR =	1	liter/day
EF =	78	days/year
ED =	5	years
AT (Nc) =	1,825	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
NA= Information not available.

TABLE A-10
CALCULATION OF INTAKE AND RISK FROM THE INGESTION OF GROUNDWATER
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

$$\text{Equation for Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Variables (Assumptions for Each Receptor are Listed at the Bottom):

CW = Chemical Concentration in Groundwater, from Groundwater EPC Data
IR = Ingestion Rate
EF = Exposure Frequency
ED=Exposure Duration
BW=Bodyweight
AT=Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Contribution to Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Oral RfD (mg/kg-day)	Carc. Slope Oral (mg/kg-day)-1	EPC Groundwater (mg/liter)	Resident (Adult) Intake (mg/kg-day) (Nc)	Resident (Adult) Intake (mg/kg-day) (Car)	Resident (Adult) Hazard Quotient	Resident (Adult) Contribution to Lifetime Cancer Risk	Resident (Child) Intake (mg/kg-day) (Nc)	Resident (Child) Intake (mg/kg-day) (Car)	Resident (Child) Hazard Quotient	Resident (Child) Contribution to Lifetime Cancer Risk	Resident Total Lifetime Cancer Risk
Semivolatile Organics												
Phenol	6.00E-001	NA	2.00E-003	5.48E-005		9E-005		1.28E-004		2E-004		
Metals												
Manganese	5.00E-002	NA	1.07E+000	2.93E-002		6E-001		6.84E-002		1E+000		
Sodium	NA	NA	1.46E+002									
Total Hazard Quotient and Cancer Risk:						**6E-001**				**1E+000**		

Assumptions for Resident (Adult)

BW =	70	kg
IR =	2	liters/day
EF =	350	days/year
ED =	24	years
AT (Nc) =	8,760	days
AT (Car) =	25,550	days

Assumptions for Resident (Child)

BW =	15	kg
IR =	1	liters/day
EF =	350	days/year
ED =	6	years
AT (Nc) =	2,190	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data.
NA= Information not available.

TABLE A-11
CALCULATION OF INTAKE AND RISK FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING)
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{DA \times SA \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom)

DA = Absorbed Dose per Event
SA = Surface Area Contact
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Absorbed Dose per Event (DA)

For organics $DA = 2Kp \times CW \sqrt{\frac{6 \times \tau \times ET}{\pi}} \times CF$

For inorganics $DA = Kp \times CW \times ET \times CF$

Kp = Permeability Coefficient
CW = EPC Cderm
ET = Exposure Time
τ = Lag Time
CF = Conversion Factor

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Permeability Coefficient Kp (cm/hr)	Tau (hours)	EPC Groundwater (mg/liter)	Absorbed Dose/Event (mg-cm²/event)	Park Worker				Recreational Visitor (Child)				Construction Worker			
							Intake (mg/kg-day)		Hazard Quotient	Cancer Risk	Intake (mg/kg-day)		Hazard Quotient	Cancer Risk	Intake (mg/kg-day)		Hazard Quotient	Cancer Risk
							(Nc)	(Car)			(Nc)	(Car)			(Nc)	(Car)		
Semivolatile Organics																		
Phenol	6.00E-001	NA	4.3E-003	3.80E-001	2.00E-003	6.26E-007	Dermal Contact to Groundwater Not Applicable for Park Worker				5.89E-005		1E-004		Dermal Contact to Groundwater Not Applicable for Construction Worker			
Metals																		
Manganese	2.00E-003	NA	1.00E-003	NA	1.07E+000	1.07E-006					1.01E-004		5E-002					
Sodium	NA	NA	1.00E-003	NA	1.46E+002	1.71E+002												
Total Hazard Quotient and Cancer Risk:													**5E-002**					

Assumptions for Recreational Visitor (Child)

CF =	0.001	l/cm3
BW =	15	kg
SA =	6,600	cm2
ET =	1.00	hours/day
EF =	78	days/year
ED =	5	years
AT (Nc) =	1,825	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
NA - Information not available

TABLE A-12
CALCULATION OF INTAKE AND RISK FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING)
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{DA \times SA \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom).

DA = Absorbed Dose per Event
SA = Surface Area Contact
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Absorbed Dose per Event (DA)

For organics $DA = 2Kp \times CW \sqrt{\frac{6 \times \tau \times ET}{\pi}} \times CF$

For inorganics DA = Kp × CW × ET × CF

Kp = Permeability Coefficient
CW = EPC Cderm
ET = Exposure Time
τ = Lag Time
CF = Conversion Factor

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Contribution to Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Permeability Coefficient Kp (cm/hr)	Tau (hours)	EPC Groundwater (mg/liter)	Absorbed Dose/Event (mg-cm²/event)	Resident (Adult) Intake (mg/kg-day) (Nc)	Resident (Adult) Intake (mg/kg-day) (Car)	Resident (Adult) Hazard Quotient	Resident (Adult) Contribution to Lifetime Cancer Risk	Resident (Child) Intake (mg/kg-day) (Nc)	Resident (Child) Intake (mg/kg-day) (Car)	Resident (Child) Hazard Quotient	Resident (Child) Contribution to Lifetime Cancer Risk	Resident Total Lifetime Cancer Risk
Semivolatile Organics															
Phenol	6.00E-001	NA	4.30E-003	3.80E-001	2.00E-003	6.26E-007	1.54E-004		3E-004		2.64E-004		4E-004		
Metals															
Manganese	2.00E-003	NA	1.00E-003	NA	1.07E+000	1.07E-006	2.64E-004		1E-001		4.51E-004		2E-001		
Sodium	NA	NA	1.00E-003	NA	1.46E+002	1.71E+002									
Total Hazard Quotient and Cancer Risk:									**1E-001**				**2E-001**		

Assumptions for Resident (Adult)

CF =	0.001	l/cm3
BW =	70	kg
SA =	18,000	cm2
ET =	0.58	hours/day
EF =	350	days/year
ED =	24	years
AT (Nc) =	8,760	days
AT (Car) =	25,550	days

Assumptions for Resident (Child)

CF =	0.001	l/cm3
BW =	15	kg
SA =	6,600	cm2
ET =	1.00	hours/day
EF =	350	days/year
ED =	6	years
AT (Nc) =	2,190	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
NA= Information not available

A-13

CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SURFACE WATER
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{DA \times SA \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom).

DA = Absorbed Dose per Event
SA = Surface Area Contact
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Absorbed Dose per Event (DA)

For organics with ET < t*. $DA = 2Kp \times CW \sqrt{\frac{6 \times \tau \times ET}{\pi}} \times CF$

For organics with ET > t* DA = Kp x CW x [ET/(1+B) + 2Tau(1+3B)/(1+B)] x CF

For inorganics DA = Kp x CW x ET x CF

Kp = Permeability Coefficient
CW = EPC Surface Water
ET = Exposure Time
Tau = Lag Time
CF = Conversion Factor

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Permeability Coefficient Kp (cm/hr)	Tau (hours)	B (unitless)	EPC Surface Water (mg/L)	Absorbed Dose/Event (mg-cm²/event)	Park Worker Intake (mg/kg-day) (Nc)	Park Worker Intake (mg/kg-day) (Car)	Park Worker Hazard Quotient	Park Worker Cancer Risk	Recreational Visitor (Child) Intake (mg/kg-day) (Nc)	Recreational Visitor (Child) Intake (mg/kg-day) (Car)	Recreational Visitor (Child) Hazard Quotient	Recreational Visitor (Child) Cancer Risk	Construction Worker Intake (mg/kg-day) (Nc)	Construction Worker Intake (mg/kg-day) (Car)	Construction Worker Hazard Quotient	Construction Worker Cancer Risk
Volatile Organics																			
Chloroform	1.00E-002	6.10E-003	6.9E-003	0.53	0.0	8.00E-004	1.11E-008	1.55E-008	5.53E-009	2E-006	3E-011	1.34E-007	9.56E-009	1E-005	6E-011	**Dermal Contact to Surface Water Not Applicable For Construction Worker**			
Toluene	2.00E-001	NA	3.2E-002	0.37	0.1	1.00E-003	5.51E-008	7.69E-008		4E-007		6.64E-007		3E-006					
Semivolatile Organics																			
4-Methylphenol	NA	NA	7.7E-003	0.45	0.0	2.20E-004	3.14E-009												
Benzo(a)pyrene	NA	7.30E+000	8.3E-001	2.83	5.0	1.00E-003	3.86E-006		1.92E-006		1E-005		3.32E-006		2E-005				
Benzo(b)fluoranthene	NA	7.30E-001	8.3E-001	2.92	5.1	9.00E-004	3.53E-006		1.76E-006		1E-006		3.04E-006		2E-006				
Benzo(ghi)perylene	NA	NA	1.2E+000	4.24		8.00E-004	5.66E-006												
Benzo(k)fluoranthene	NA	7.30E-002	7.6E-001	3.03		1.00E-003	3.65E-006		1.82E-006		1E-007		3.15E-006		2E-007				
bis(2-Ethylhexyl)phthalate	2.00E-002	1.40E-002	2.9E-002	17.44	0.2	6.80E-002	2.28E-005	3.18E-005	1.13E-005	2E-003	2E-007	2.74E-004	1.96E-005	1E-002	3E-007				
Butylbenzylphthalate	2.00E-001	NA	4.2E-002	7.04		2.30E-004	7.03E-008	9.80E-008		5E-007		8.47E-007		4E-006					
Di-n-butylphthalate	1.00E-001	NA	2.6E-002	4.06	0.2	1.50E-004	2.17E-008	3.03E-008		3E-007		2.62E-007		3E-006					
Dibenz(a,h)anthracene	NA	7.30E+000	1.8E+000	4.08	11.7	8.00E-004	8.04E-006		4.01E-006		3E-005		6.92E-006		5E-005				
Diethyl phthalate	8.00E-001	NA	4.00E-003	1.97	0.0	2.90E-004	4.50E-009	6.28E-009		8E-009		5.42E-008		7E-008					
Fluoranthene	4.00E-002	NA	2.5E-001	1.53	1.4	7.00E-004	5.98E-007	8.35E-007		2E-005		7.21E-006		2E-004					
Indeno(1,2,3-cd)pyrene	NA	7.30E-001	1.3E+000	3.97	8.0	9.00E-004	6.44E-006		3.21E-006		2E-006		5.55E-006		4E-006				
Pentachlorophenol	3.00E-002	1.20E-001	4.6E-001	3.50	2.9	1.00E-003	2.38E-006	3.32E-006	1.18E-006	1E-004	1E-007	2.87E-005	2.05E-006	1E-003	2E-007				
Phenanthrene	NA	NA	1.6E-001	1.12	0.8	5.70E-005	2.67E-008												
Phenol	6.00E-001	NA	4.3E-003	0.38	0.0	8.00E-004	6.05E-009	8.44E-009		1E-008		7.30E-008		1E-007					
Pyrene	3.00E-002	NA	2.2E-001	1.50		5.00E-004	3.68E-007	5.13E-007		2E-005		4.43E-006		1E-004					
Pesticides/PCBs																			
4,4'-DDD	NA	2.40E-001	2.1E-001	6.98	1.4	2.60E-005	3.99E-008		1.99E-008		5E-009		3.43E-008		8E-009				
4,4'-DDE	NA	3.40E-001	1.8E-001	6.80	1.2	5.10E-006	6.62E-009		3.30E-009		1E-009		5.70E-009		2E-009				
4,4'-DDT	5.00E-004	3.40E-001	3.2E-001	10.96	2.3	4.60E-005	1.35E-007	1.88E-007	6.71E-008	4E-004	2E-008	1.62E-006	1.16E-007	3E-003	4E-008				
Endosulfan sulfate	6.00E-003	NA	1.9E-003	26.55		1.40E-005	3.83E-010	5.35E-010		9E-008		4.62E-009		8E-007					
Endrin	3.00E-004	NA	1.4E-002	15.33	0.1	5.20E-005	7.88E-009	1.10E-008		4E-005		9.50E-008		3E-004					
Endrin aldehyde	NA	NA	1.4E-002	15.33	0.1	6.20E-005	9.39E-009												
Endrin ketone	NA	NA	1.4E-002	15.33	0.1	4.60E-005	6.97E-009												
gamma-Chlordane	5.00E-004	3.50E-001	1.2E-002	4.80	0.1	4.00E-006	2.91E-010	4.05E-010	1.45E-010	8E-007	5E-011	3.50E-009	2.50E-010	7E-006	9E-011				
Heptachlor	5.00E-004	4.50E+000	9.6E-003	13.91	0.1	3.60E-006	3.56E-010	4.97E-010	1.77E-010	1E-006	8E-010	4.29E-009	3.07E-010	9E-006	1E-009				
Heptachlor epoxide	1.30E-005	9.10E+000	2.3E-002	20.73		3.00E-006	8.58E-010	1.20E-009	4.27E-010	9E-005	4E-009	1.03E-008	7.39E-010	8E-004	7E-009				
Metals																			
Aluminum	1.00E+000	NA	1.00E-003	NA	NA	3.63E+000	3.63E-006	5.06E-006		5E-006		4.38E-005		4E-005					
Arsenic	3.00E-004	1.50E+000	1.00E-003	NA	NA	3.80E-003	3.80E-009	5.30E-009	1.89E-009	2E-005	3E-009	4.58E-008	3.27E-009	2E-004	5E-009				
Barium	4.90E-003	NA	1.00E-003	NA	NA	9.14E-002	9.14E-008	1.27E-007		3E-005		1.10E-006		2E-004					
Beryllium	1.40E-005	NA	1.00E-003	NA	NA	1.90E-004	1.90E-010	2.65E-010		2E-005		2.29E-009		2E-004					
Cadmium	1.25E-005	NA	1.00E-003	NA	NA	7.80E-004	7.80E-010	1.09E-009		9E-005		9.40E-009		8E-004					
Calcium	NA	NA	1.00E-003	NA	NA	2.20E+002	2.20E-004												
Chromium	7.50E-005	NA	2.00E-003	NA	NA	5.60E-003	1.12E-008	1.56E-008		2E-004		1.35E-007		2E-003					
Cobalt	2.00E-002	5.00E-006	4.00E-004	NA	NA	7.20E-003	2.88E-009	4.02E-009	1.43E-009	2E-007	7E-015	3.47E-008	2.48E-009	2E-006	1E-014				
Copper	4.00E-002	NA	1.00E-003	NA	NA	7.90E-003	7.90E-009	1.10E-008		3E-007		9.52E-008		2E-006					
Iron	3.00E-001	NA	1.00E-003	NA	NA	9.05E+000	9.05E-006	1.26E-005		4E-005		1.09E-004		4E-004					
Lead	NA	NA	1.00E-004	NA	NA	2.00E-002	2.00E-009												
Magnesium	NA	NA	1.00E-003	NA	NA	3.37E+001	3.37E-005												
Manganese	2.00E-003	NA	1.00E-003	NA	NA	2.30E+000	2.30E-006	3.21E-006		2E-003		2.77E-005		1E-002					
Mercury	2.10E-005	NA	1.00E-003	NA	NA	1.00E-004	1.00E-010	1.39E-010		7E-006		1.21E-009		6E-005					
Nickel	8.00E-004	NA	2.00E-004	NA	NA	1.88E-002	3.76E-009	5.24E-009		7E-006		4.53E-008		6E-005					
Potassium	NA	NA	2.00E-003	NA	NA	1.16E+001	2.32E-005												
Silver	2.00E-004	NA	6.00E-004	NA	NA	8.90E-004	5.34E-010	7.45E-010		4E-006		6.44E-009		3E-005					
Sodium	NA	NA	1.00E-003	NA	NA	5.93E+001	5.93E-005												
Thallium	8.00E-005	NA	1.00E-003	NA	NA	1.90E-003	1.90E-009	2.65E-009		3E-005		2.29E-008		3E-004					
Vanadium	1.82E-004	NA	1.00E-003	NA	NA	8.90E-003	8.90E-009	1.24E-008		7E-005		1.07E-007		6E-004					
Zinc	3.00E-001	NA	6.00E-004	NA	NA	9.90E-002	5.94E-008	8.29E-008		3E-007		7.16E-007		2E-006					
Total Hazard Quotient and Cancer Risk:										4E-003	5E-005			4E-002	8E-005				

. .BLE A-13
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SURFACE WATER
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{DA \times SA \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom)

DA = Absorbed Dose per Event

SA = Surface Area Contact

EF = Exposure Frequency

ED = Exposure Duration

BW = Bodyweight

AT = Averaging Time

Equation for Absorbed Dose per Event (DA)

For organics with ET < t*: DA = 2Kp x CW x [illegible] CF

For organics with ET > t*: DA = Kp x CW x [ET/(1+B) + 2Tau(1+3B)/(1+B)] x CF

For inorganics: DA = Kp x CW x ET x CF

Kp = Permeability Coefficient

CW = EPC Surface Water

ET = Exposure Time

Tau = Lag Time

CF = Conversion Factor

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Permeability Coefficient Kp (cm/hr)	Tau (hours)	B (unitless)	EPC Surface Water (mg/L)	Absorbed Dose/Event (mg-cm²/event)	Park Worker Intake (mg/kg-day) (Nc)	Park Worker Intake (mg/kg-day) (Car)	Park Worker Hazard Quotient	Park Worker Cancer Risk	Recreational Visitor (Child) Intake (mg/kg-day) (Nc)	Recreational Visitor (Child) Intake (mg/kg-day) (Car)	Recreational Visitor (Child) Hazard Quotient	Recreational Visitor (Child) Cancer Risk	Construction Worker Intake (mg/kg-day) (Nc)	Construction Worker Intake (mg/kg-day) (Car)	Construction Worker Hazard Quotient	Construction Worker Cancer Risk
								Assumptions for Park Worker				Assumptions for Recreational Visitor (Child)							
								CF =	1E-003	liter/cm3		CF =	1E-003	liter/cm3					
								BW =	70	kg		DW =	15	kg					
								SA =	1,980	cm2		SA =	3,300	cm2					
								ET =	1	hour/day		ET =	1	hour/day					
								EF =	18	days/year		EF =	20	days/year					
								ED =	25	years		ED =	5	years					
								AT (Nc) =	9,125	days		AT (Nc) =	1,825	days					
								AT (Car) =	25,550	days		AT (Car) =	25,550	days					

Notes

1 Cells in this table were intentionally left blank due to a lack of toxicity data

2 Kp, B and Tou were taken from EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual, Supplement Guidance Dermal Risk Assessment Interim Guidance, 1999

Where Kp and B were not availabe, they were calculated according to the guidance Kow values from SRC PhysProp Database were used to estimate Kp (http //esc syrres com/interkow/physdemo htm)

TABL

CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SURFACE WATER

REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63

EE/CA - Mini Risk Assessment

Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{DA \times SA \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom).

DA = Absorbed Dose per Event	ED = Exposure Duration
SA = Surface Area Contact	BW = Bodyweight
EF - Exposure Frequency	AT = Averaging Time

Equation for Absorbed Dose per Event (DA)

For organics with ET < t* [illegible]

For organics with ET > t DA = Kp x CW x [ET/(1+B) + 2Tau(1+3B)/(1+B)] x CF

For inorganics DA = Kp x CW x ET x CF

Kp = Permeability Coefficient

CW = EPC Surface Water

ET = Exposure Time

Tau = Lag Time

CF = Conversion Factor

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Contribution to Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Dermal RfD	Carc. Slope Dermal	Permeability Coefficient	Tau	B	EPC Surface Water	Absorbed Dose/Event	Resident (Adult)				Resident (Child)				Resident
								Intake (mg/kg-day)		Hazard Quotient	Contribution to Lifetime Cancer Risk	Intake (mg/kg-day)		Hazard Quotient	Contribution to Lifetime Cancer Risk	Total Lifetime Cancer Risk
	(mg/kg-day)	(mg/kg-day)-1	Kp (cm/hr)	(hours)	(unitless)	(mg/L)	(mg-cm²/event)	(Nc)	(Car)			(Nc)	(Car)			
Volatile Organics																
Chloroform	1 00E-002	6 10E-003	6 9E-003	0 53	0 0	8 00E-004	1 11E-008	1 61E-008	5 53E-009	2E-006	3E-011	1 34E-007	9 56E-009	1E-005	6E-011	9E-011
Toluene	2 00E-001	NA	3 2E-002	0 37	0 1	1 00E-003	5 51E-008	8 01E-008		4E-007		6 64E-007		3E-006		
Semivolatile Organics																
4-Methylphenol	NA	NA	7 7E-003	0 45	0 0	2 20E-004	3 14E-009									
Benzo(a)pyrene	NA	7 30E+000	8 3E-001	2 83	5 0	1 00E-003	3 86E-006		1 92E-006		1E-005		3 32E-006		2E-005	4E-005
Benzo(b)fluoranthene	NA	7 30E-001	8 3E-001	2 92	5 1	9 00E-004	3 53E-006		1 76E-006		1E-006		3 04E-006		2E-006	4E-006
Benzo(ghi)perylene	NA	NA	1 2E+000	4 24		8 00E-004	5 66E-006									
Benzo(k)fluoranthene	NA	7 30E-002	7 6E-001	3 03		1 00E-003	3 65E-006		1 82E-006		1E-007		3 15E-006		2E-007	4E-007
bis(2-Ethylhexyl)phthalate	2 00E-002	1 40E-002	2 9E-002	17 44	0 2	6 80E-002	2 28E-005	3 31E-005	1 13E-005	2E-003	2E-007	2 74E-004	1 96E-005	1E-002	3E-007	4E-007
Butylbenzylphthalate	2 00E-001	NA	4 2E-002	7 04		2 30E-004	7 03E-008	1 02E-007		5E-007		8 47E-007		4E-006		
Di-n-butylphthalate	1 00E-001	NA	2 6E-002	4 06	0 2	1 50E-004	2 17E-008	3 16E-008		3E-007		2 62E-007		3E-006		
Dibenz(a,h)anthracene	NA	7 30E+000	1 8E+000	4 08	11 7	8 00E-004	8 04E-006		4 01E-006		3E-005		6 92E-006		5E-005	8E-005
Diethylphthalate	8 00E-001	NA	4 00E-003	1 97	0 0	2 90E-004	4 50E-009	6 54E-009		8E-009		5 42E-008		7E-008		
Fluoranthene	4 00E-002	NA	2 5E-001	1 53	1 4	7 00E-004	5 98E-007	8 69E-007		2E-005		7 21E-006		2E-004		
Indeno(1,2 3-cd)pyrene	NA	7 30E-001	1 3E+000	3 97	8 0	9 00E-004	6 44E-006		3 21E-006		2E-006		5 55E-006		4E-006	6E-006
Pentachlorophenol	3 00E-002	1 20E-001	4 6E-001	3 50	2 9	1 00E-003	2 38E-006	3 46E-006	1 18E-006	1E-004	1E-007	2 87E-005	2 05E-006	1E-003	2E-007	4E-007
Phenanthrene	NA	NA	1 6E-001	1 12	0 8	5 70E-005	2 67E-008									
Phenol	6 00E-001	NA	4 3E-003	0 38	0 0	8 00E-004	6 05E-009	8 79E-009		1E-008		7 30E-008		1E-007		
Pyrene	3 00E-002	NA	2 2E-001	1 50		5 00E-004	3 68E-007	5 34E-007		2E-005		4 43E-006		1E-004		
Pesticides/PCBs																
4 4'-DDD	NA	2 40E-001	2 1E-001	6 98	1 4	2 60E-005	3 99E-008		1 99E-008		5E-009		3 43E-008		8E-009	1E-008
4,4'-DDE	NA	3 40E-001	1 8E-001	6 80	1 2	5 10E-006	6 62E-009		3 30E-009		1E-009		5 70E-009		2E-009	3E-009
4,4'-DDT	5 00E-004	3 40E-001	3 2E-001	10 96	2 3	4 60E-005	1 35E-007	1 96E-007	6 71E-008	4E-004	2E-008	1 62E-006	1 16E-007	3E-003	4E-008	6E-008
Endosulfan sulfate	6 00E-003	NA	1 9E-003	26 55		1 40E-005	3 83E-010	5 57E-010		9E-008		4 62E-009		8E-007		0E+000
Endrin	3 00E-004	NA	1 4E-002	15 33	0 1	5 20E-005	7 88E-009	1 14E-008		4E-005		9 50E-008		3E-004		0E+000
Endrin aldehyde	NA	NA	1 4E-002	15 33	0 1	6 20E-005	9 39E-009									
Endrin ketone	NA	NA	1 4E-002	15 33	0 1	4 60E-005	6 97E-009									
gamma-Chlordane	5 00E-004	3 50E-001	1 2E-002	4 80	0 1	4 00E-006	2 91E-010	4 22E-010	1 45E-010	8E-007	5E-011	3 50E-009	2 50E-010	7E-006	9E-011	1E-010
Heptachlor	5 00E-004	4 50E+000	9 6E-003	13 91	0 1	3 60E-006	3 56E-010	5 18E-010	1 77E-010	1E-006	8E-010	4 29E-009	3 07E-010	9E-006	1E-009	2E-009
Heptachlor epoxide	1 30E-005	9 10E+000	2 3E-002	20 73		3 00E-006	8 58E-010	1 25E-009	4 27E-010	1E-004	4E-009	1 03E-008	7 39E-010	8E-004	7E-009	1E-008
Metals																
Aluminum	1 00E+000	NA	1 00E-003	NA	NA	3 63E+000	3 63E-006	5 27E-006		5E-006		4 38E-005		4E-005		
Arsenic	3 00E-004	1 50E+000	1 00E-003	NA	NA	3 80E-003	3 80E-009	5 52E-009	1 89E-009	2E-005	3E-009	4 58E-008	3 27E-009	2E-004	5E-009	8E-009
Barium	4 90E-003	NA	1 00E-003	NA	NA	9 14E-002	9 14E-008	1 33E-007		3E-005		1 10E-006		2E-004		
Beryllium	1 40E-005	NA	1 00E-003	NA	NA	1 90E-004	1 90E-010	2 76E-010		2E-005		2 29E-009		2E-004		
Cadmium	1 25E-005	NA	1 00E-003	NA	NA	7 80E-004	7 80E-010	1 13E-009		9E-005		9 40E-009		8E-004		
Calcium	NA	NA	1 00E-003	NA	NA	2 20E+002	2 20E-004									
Chromium	7 50E-005	NA	2 00E-003	NA	NA	5 60E-003	1 12E-008	1 63E-008		2E-004		1 35E-007		2E-003		
Cobalt	2 00E-002	5 00E-006	4 00E-004	NA	NA	7 20E-003	2 88E-009	4 18E-009	1 43E-009	2E-007	7E-015	3 47E-008	2 48E-009	2E-006	1E-014	2E-014
Copper	4 00E-002	NA	1 00E-003	NA	NA	7 90E-003	7 90E-009	1 15E-008		3E-007		9 52E-008		2E-006		
Iron	3 00E-001	NA	1 00E-003	NA	NA	9 05E+000	9 05E-006	1 31E-005		4E-005		1 09E-004		4E-004		
Lead	NA	NA	1 00E-004	NA	NA	2 00E-002	2 00E-009									
Magnesium	NA	NA	1 00E-003	NA	NA	3 37E+001	3 37E-005									
Manganese	2 00E-003	NA	1 00E-003	NA	NA	2 30E+000	2 30E-006	3 34E-006		2E-003		2 77E-005		1E-002		
Mercury	2 10E-005	NA	1 00E-003	NA	NA	1 00E-004	1 00E-010	1 45E-010		7E-006		1 21E-009		6E-005		
Nickel	8 00E-004	NA	2 00E-004	NA	NA	1 88E-002	3 76E-009	5 46E-009		7E-006		4 53E-008		6E-005		
Potassium	NA	NA	2 00E-003	NA	NA	1 16E+001	2 32E-005									
Silver	2 00E-004	NA	6 00E-004	NA	NA	8 90E-004	5 34E-010	7 76E-010		4E-006		6 44E-009		3E-005		
Sodium	NA	NA	1 00E-003	NA	NA	5 93E+001	5 93E-005									
Thallium	8 00E-005	NA	1 00E-003	NA	NA	1 90E-003	1 90E-009	2 76E-009		3E-005		2 29E-008		3E-004		
Vanadium	1 82E-004	NA	1 00E-003	NA	NA	8 90E-003	8 90E-009	1 29E-008		7E-005		1 07E-007		6E-004		
Zinc	3 00E-001	NA	6 00E-004	NA	NA	9 90E-002	5 94E-008	8 63E-008		3E-007		7 16E-007		2E-006		
Total Hazard Quotient and Cancer Risk:										5E-003	5E-005			4E-002	8E-005	1E-004

TABL.. 14
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SURFACE WATER
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{DA \times SA \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom).

DA = Absorbed Dose per Event
ED = Exposure Duration
SA = Surface Area Contact
BW = Bodyweight
EF = Exposure Frequency
AT = Averaging Time

Equation for Absorbed Dose per Event (DA)

For organics with ET < t*, $DA = 2Kp \times CW \sqrt{\frac{6 \tau \times ET}{\pi}} \times CF$

For organics with ET > t*: $DA = Kp \times CW \times [ET/(1+B) + 2Tau(1+3B)/(1+B)] \times CF$

For inorganics: $DA = Kp \times CW \times ET \times CF$

Kp = Permeability Coefficient
Tau = Lag Time
CW = EPC Surface Water
CF = Conversion Factor
ET = Exposure Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose
Equation for Contribution to Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Permeability Coefficient Kp (cm/hr)	Tau (hours)	B (unitless)	EPC Surface Water (mg/L)	Absorbed Dose/Event (mg-cm²/event)	Resident (Adult) Intake (mg/kg-day) (Nc)	Resident (Adult) Intake (mg/kg-day) (Car)	Resident (Adult) Hazard Quotient	Resident (Adult) Contribution to Lifetime Cancer Risk	Resident (Child) Intake (mg/kg-day) (Nc)	Resident (Child) Intake (mg/kg-day) (Car)	Resident (Child) Hazard Quotient	Resident (Child) Contribution to Lifetime Cancer Risk	Resident Total Lifetime Cancer Risk
								Assumptions for Resident (Adult)				Assumptions for Resident (Child)				
								CF =	1E-003	liter/cm3		CF =	1E-003	liter/cm3		
								BW =	70	kg		BW =	15	kg		
								SA =	4,500	cm2		SA =	3,300	cm2		
								ET =	0.5	hour/day		ET =	1	hour/day		
								EF =	35	days/year		EF =	35	days/year		
								ED =	24	years		ED =	6	years		
								AT (Nc) =	8,760	days		AT (Nc) =	2,190	days		
								AT (Car) =	25,550	days		AT (Car) =	25,550	days		

Notes

1 Cells in this table were intentionally left blank due to a lack of toxicity data

2 Kp, B, and Tau were taken from EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual, Supplement Guidance Dermal Risk Assessment Interim Guidance, 1999
Where Kp and B were not availabe, they were calculated according to the guidance Kow values from SRC PhysProp Database were used to estimate Kp (http //esc syrres com/interkow/physdemo htm)

TABLE A-15
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SEDIMENT
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Variables (Assumptions for Each Receptor are Listed at the Bottom)
CS = Chemical Concentration in Sediment, from Sediment EPC Data
CF = Conversion Factor
SA = Surface Area Contact
AF = Adherence Factor
ABS = Absorption Factor
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Absorption Factor* (unitless)	EPC Sediment (mg/kg)	Park Worker				Recreational Visitor (Child)				Construction Worker			
					Absorbed Dose (mg/kg-day)		Hazard Quotient	Cancer Risk	Absorbed Dose (mg/kg-day)		Hazard Quotient	Cancer Risk	Absorbed Dose (mg/kg-day)		Hazard Quotient	Cancer Risk
					(Nc)	(Car)			(Nc)	(Car)			(Nc)	(Car)		
Volatile Organics																
Acetone	1.00E-001	NA	NA	1.50E-001									Dermal Contact to Sediment Not Applicaple for for Construction Worker			
Methyl ethyl ketone	6.00E-001	NA	NA	3.50E-002												
Toluene	2.00E-001	NA	NA	1.40E-002												
Semivolatile Organics																
2-Methylnaphthalene	4.00E-002	NA	0.10	1.40E-002	1.12E-009		3E-008		1.12E-008		3E-007					
Benzo(a)anthracene	NA	7.30E-001	0.13	2.00E+000		7.46E-008		5E-008		1.48E-007		1E-007				
Benzo(a)pyrene	NA	7.30E+000	0.13	2.70E+000		1.01E-007		7E-007		2.00E-007		1E-006				
Benzo(b)fluoranthene	NA	7.30E-001	0.13	3.50E+000		1.31E-007		1E-007		2.59E-007		2E-007				
Benzo(k)fluoranthene	NA	7.30E-002	0.13	1.90E+000		7.08E-008		5E-009		1.41E-007		1E-008				
bis(2-Ethylhexyl)phthalate	2.00E-002	1.40E-002	0.10	1.10E-001	8.83E-009	3.16E-009	4E-007	4E-011	8.78E-008	6.27E-009	4E-006	9E-011				
Butylbenzylphthalate	2.00E-001	NA	0.10	2.20E-002	1.77E-009		9E-009		1.76E-008		9E-008					
Carbazole	NA	2.00E-002	0.10	4.30E-001		1.23E-008		2E-010		2.45E-008		5E-010				
Chrysene	NA	7.30E-003	0.10	2.20E+000		6.31E-008		5E-010		1.25E-007		9E-010				
Di-n-butylphthalate	1.00E-001	NA	0.10	1.90E-002	1.53E-009		2E-008		1.52E-008		2E-007					
Di-n-octylphthalate	NA	NA	0.10	1.90E-002												
Dibenz(a,h)anthracene	NA	7.30E+000	0.13	1.20E+000		4.47E-008		3E-007		8.89E-008		6E-007				
Dibenzofuran	NA	NA	0.10	3.60E-002												
Diethylphthalate	8.00E-001	NA	0.10	9.20E-002	7.39E-009		9E-009		7.34E-008		9E-008					
Fluoranthene	4.00E-002	NA	0.13	4.30E+000	4.49E-007		1E-005		4.46E-006		1E-004					
Fluorene	4.00E-002	NA	0.13	1.10E-001	1.15E-008		3E-007		1.14E-007		3E-006					
Indeno(1,2,3-cd)pyrene	NA	7.30E-001	0.13	2.50E+000		9.32E-008		7E-008		1.85E-007		1E-007				
Naphthalene	2.00E-002	NA	0.13	2.30E-002	2.40E-009		1E-007		2.39E-008		1E-006					
Phenanthrene	NA	NA	0.13	1.50E+000												
Phenol	6.00E-001	NA	0.10	1.10E-002	8.83E-010		1E-009		8.78E-009		1E-008					
Pyrene	3.00E-002	NA	0.13	3.20E+000	3.34E-007		1E-005		3.32E-006		1E-004					
Pesticides/PCBs																
4,4'-DDD	NA	2.40E-001	0.03	3.90E-003		3.36E-011		8E-012		6.67E-011		2E-011				
4,4'-DDE	NA	3.40E-001	0.03	9.20E-003		7.92E-011		3E-011		1.57E-010		5E-011				
4,4'-DDT	5.00E-004	3.40E-001	0.03	8.30E-003	2.00E-010	7.14E-011	4E-007	2E-011	1.99E-009	1.42E-010	4E-006	5E-011				
alpha-Chlordane	5.00E-004	3.50E-001	0.04	3.20E-003	1.03E-010	3.67E-011	2E-007	1E-011	1.02E-009	7.29E-011	2E-006	3E-011				
Aroclor-1260	2.00E-005	2.00E+000	0.14	1.10E-001	1.24E-008	4.42E-009	6E-004	9E-009	1.23E-007	8.78E-009	6E-003	2E-008				
Endosulfan I	6.00E-003	NA	0.10	7.50E-003	6.02E-010		1E-007		5.98E-009		1E-006					
Endosulfan sulfate	6.00E-003	NA	0.10	1.20E-002	9.64E-010		2E-007		9.57E-009		2E-006					
Endrin aldehyde	NA	NA	0.10	8.60E-003												
Endrin ketone	NA	NA	0.10	9.40E-003												
Metals																
Aluminum	1.00E+000	NA	NA	1.67E+004												
Arsenic	3.00E-004	1.50E+000	3.00E-002	6.80E+000	1.64E-007	5.85E-008	5E-004	9E-008	1.63E-006	1.16E-007	5E-003	2E-007				
Barium	4.90E-003	NA	NA	1.07E+002												
Beryllium	1.40E-005	NA	NA	8.00E-001												
Cadmium	1.25E-005	NA	1.00E-003	8.30E-001	6.67E-010		5E-005		6.62E-009		5E-004					
Calcium	NA	NA	NA	2.11E+005												
Chromium	7.50E-005	NA	NA	2.44E+001												
Cobalt	2.00E-002	5.00E-006	NA	1.44E+001												
Copper	4.00E-002	NA	NA	4.26E+001												
Cyanide	2.00E-002	NA	NA	2.10E+000												
Iron	3.00E-001	NA	NA	2.97E+004												
Lead	NA	NA	NA	4.62E+001												
Magnesium	NA	NA	NA	1.61E+004												
Manganese	2.00E-003	NA	NA	9.95E+002												
Mercury	2.10E-005	NA	NA	1.30E-001												
Nickel	8.00E-004	NA	NA	4.42E+001												

TABLE A-15
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SEDIMENT
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom)

CS = Chemical Concentration in Sediment, from Sediment EPC Data
CF = Conversion Factor
SA = Surface Area Contact
AF = Adherence Factor
ABS = Absorption Factor

EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose

Equation for Cancer Risk = Chronic Daily Intake (Car) x Slope Factor

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Absorption Factor* (unitless)	EPC Sediment (mg/kg)	Park Worker Absorbed Dose (mg/kg-day) (Nc)	Park Worker Absorbed Dose (mg/kg-day) (Car)	Park Worker Hazard Quotient	Park Worker Cancer Risk	Recreational Visitor (Child) Absorbed Dose (mg/kg-day) (Nc)	Recreational Visitor (Child) Absorbed Dose (mg/kg-day) (Car)	Recreational Visitor (Child) Hazard Quotient	Recreational Visitor (Child) Cancer Risk	Construction Worker Absorbed Dose (mg/kg-day) (Nc)	Construction Worker Absorbed Dose (mg/kg-day) (Car)	Construction Worker Hazard Quotient	Construction Worker Cancer Risk
Potassium	NA	NA	NA	2.57E+003												
Selenium	5.00E-003	NA	NA	2.10E+000												
Sodium	NA	NA	NA	5.78E+002												
Thallium	8.00E-005	NA	NA	2.30E+000												
Vanadium	1.82E-004	NA	NA	2.80E+001												
Zinc	3.00E-001	NA	NA	5.34E+002												
Total Hazard Quotient and Cancer Risk:							1E-003	1E-006			1E-002	3E-006				

Assumptions for Park Worker

CF =	1E-006	kg/mg
BW =	70	kg
SA =	5,700	cm2
AF =	0.2	mg/cm2
EF =	18	days/year
ED =	25	years
AT (Nc) =	9,125	days
AT (Car) =	25,550	days

Assumptions for Recreational Visitor (Child)

CF =	1E-006	kg/mg
BW =	15	kg
SA =	2,800	cm2
AF =	0.2	mg/cm2
EF =	78	days/year
ED =	5	years
AT (Nc) =	1,825	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
NA = Information not available
Absorption factors are from EPA Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplement Guidance: Dermal Risk Assessment, 1999

TABLE A-16
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SEDIMENT
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom)

CS = Chemical Concentration in Sediment, from Sediment EPC Data
CF = Conversion Factor
SA = Surface Area Contact
AF = Adherence Factor
ABS = Absorption Factor
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose
Equation for Contribution to Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Absorption Factor* (unitless)	EPC Sediment (mg/kg)	Resident (Adult)				Resident (Child)				Resident
					Absorbed Dose (mg/kg-day) (Nc)	Absorbed Dose (mg/kg-day) (Car)	Hazard Quotient	Contribution to Lifetime Cancer Risk	Absorbed Dose (mg/kg-day) (Nc)	Absorbed Dose (mg/kg-day) (Car)	Hazard Quotient	Contribution to Lifetime Cancer Risk	Total Lifetime Cancer Risk
Volatile Organics													
Acetone	1 00E-001	NA	NA	1 50E-001									
Methyl ethyl ketone	6 00E-001	NA	NA	3 50E-002									
Toluene	2 00E-001	NA	NA	1 40E-002									
Semivolatile Organics													
2-Methylnaphthalene	4 00E-002	NA	0 10	1 40E-002	1 12E-009		3E-008		1 12E-008		3E-007		
Benzo(a)anthracene	NA	7 30E-001	0 13	2 00E+000		7 46E-008		5E-008		1 48E-007		1E-007	1 63E-007
Benzo(a)pyrene	NA	7 30E+000	0 13	2 70E+000		1 01E-007		7E-007		2 00E-007		1E-006	2 20E-006
Benzo(b)fluoranthene	NA	7 30E-001	0 13	3 50E+000		1 31E-007		1E-007		2 59E-007		2E-007	2 85E-007
Benzo(k)fluoranthene	NA	7 30E-002	0 13	1 90E+000		7 08E-008		5E-009		1 41E-007		1E-008	1 54E-008
bis(2-Ethylhexyl)phthalate	2 00E-002	1 40E-002	0 10	1 10E-001	8 83E-009	3 16E-009	4E-007	4E-011	8 78E-008	6 27E-009	4E-006	9E-011	1 32E-010
Butylbenzylphthalate	2 00E-001	NA	0 10	2 20E-002	1 77E-009		9E-009		1 76E-008		9E-008		
Carbazole	NA	2 00E-002	0 10	4 30E-001		1 23E-008		2E-010		2 45E-008		5E-010	7 37E-010
Chrysene	NA	7 30E-003	0 10	2 20E+000		6 31E-008		5E-010		1 25E-007		9E-010	1 38E-009
Di-n-butylphthalate	1 00E-001	NA	0 10	1 90E-002	1 53E-009		2E-008		1 52E-008		2E-007		
Di-n-octylphthalate	NA	NA	0 10	1 90E-002									
Dibenz(a,h)anthracene	NA	7 30E+000	0 13	1 20E+000		4 47E-008		3E-007		8 89E-008		6E-007	9 76E-007
Dibenzofuran	NA	NA	0 10	3 60E-002									
Diethyl phthalate	8 00E-001	NA	0 10	9 20E-002	7 39E-009		9E-009		7 34E-008		9E-008		
Fluoranthene	4 00E-002	NA	0 13	4 30E+000	4 49E-007		1E-005		4 46E-006		1E-004		
Fluorene	4 00E-002	NA	0 13	1 10E-001	1 15E-008		3E-007		1 14E-007		3E-006		
Indeno(1,2,3-cd)pyrene	NA	7 30E-001	0 13	2 50E+000		9 32E-008		7E-008		1 85E-007		1E-007	2 03E-007
Naphthalene	2 00E-002	NA	0 13	2 30E-002	2 40E-009		1E-007		2 39E-008		1E-006		
Phenanthrene	NA	NA	0 13	1 50E+000									
Phenol	6 00E-001	NA	0 10	1 10E-002	8 83E-010		1E-009		8 78E-009		1E-008		
Pyrene	3 00E-002	NA	0 13	3 20E+000	3 34E-007		1E-005		3 32E-006		1E-004		
Pesticides/PCBs													
4,4'-DDD	NA	2 40E-001	0 03	3 90E-003		3 36E-011		8E-012		6 67E-011		2E-011	2 41E-011
4,4'-DDE	NA	3 40E-001	0 03	9 20E-003		7 92E-011		3E-011		1 57E-010		5E-011	8 04E-011
4,4'-DDT	5 00E-004	3 40E-001	0 03	8 30E-003	2 00E-010	7 14E-011	4E-007	2E-011	1 99E-009	1 42E-010	4E-006	5E-011	7 25E-011
alpha-Chlordane	5 00E-004	3 50E-001	0 04	3 20E-003	1 03E-010	3 67E-011	2E-007	1E-011	1 02E-009	7 29E-011	2E-006	3E-011	3 84E-011
Aroclor-1260	2 00E-005	2 00E+000	0 14	1 10E-001	1 24E-008	4 42E-009	6E-004	9E-009	1 23E-007	8 78E-009	6E-003	2E-008	2 64E-008
Endosulfan I	6 00E-003	NA	0 10	7 50E-003	6 02E-010		1E-007		5 98E-009		1E-006		
Endosulfan sulfate	6 00E-003	NA	0 10	1 20E-002	9 64E-010		2E-007		9 57E-009		2E-006		
Endrin aldehyde	NA	NA	0 10	8 60E-003									
Endrin ketone	NA	NA	0 10	9 40E-003									
Metals													
Aluminum	1 00E+000	NA	NA	1 67E+004									
Arsenic	3 00E-004	1 50E+000	3 00E-002	6 80E+000	1 64E-007	5 85E-008	5E-004	9E-008	1 63E-006	1 16E-007	5E-003	2E-007	2 62E-007
Barium	4 90E-003	NA	NA	1 07E+002									
Beryllium	1 40E-005	NA	NA	8 00E-001									
Cadmium	1 25E-005	NA	1 00E-003	8 30E-001	6 67E-010		5E-005		6 62E-009		5E-004		
Calcium	NA	NA	NA	2 11E+005									
Chromium	7 50E-005	NA	NA	2 44E+001									
Cobalt	2 00E-002	5 00E-006	NA	1 44E+001									
Copper	4 00E-002	NA	NA	4 26E+001									
Cyanide	2 00E-002	NA	NA	2 10E+000									
Iron	3 00E-001	NA	NA	2 97E+004									
Lead	NA	NA	NA	4 62E+001									
Magnesium	NA	NA	NA	1 61E+004									
Manganese	2 00E-003	NA	NA	9 95E+002									
Mercury	2 10E-005	NA	NA	1 30E-001									
Nickel	8 00E-004	NA	NA	4 42E+001									

TABLE A-16
CALCULATION OF ABSORBED DOSE AND RISK FROM DERMAL CONTACT TO SEDIMENT
REASONABLE MAXIMUM EXPOSURE (RME) - SEAD-63
EE/CA - Mini Risk Assessment
Seneca Army Depot Activity

Equation for Intake (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables (Assumptions for Each Receptor are Listed at the Bottom)

CS = Chemical Concentration in Sediment, from Sediment EPC Data
CF = Conversion Factor
SA = Surface Area Contact
AF = Adherence Factor
ABS = Absorption Factor
EF = Exposure Frequency
ED = Exposure Duration
BW = Bodyweight
AT = Averaging Time

Equation for Hazard Quotient = Chronic Daily Intake (Nc)/Reference Dose
Equation for Contribution to Cancer Risk = Chronic Daily Intake (Car) x Slope Factor
Equation for Total Lifetime Cancer Risk = Adult Contribution + Child Contribution

Analyte	Dermal RfD (mg/kg-day)	Carc. Slope Dermal (mg/kg-day)-1	Absorption Factor* (unitless)	EPC Sediment (mg/kg)	Resident (Adult) Absorbed Dose (mg/kg-day) (Nc)	Resident (Adult) Absorbed Dose (mg/kg-day) (Car)	Resident (Adult) Hazard Quotient	Resident (Adult) Contribution to Lifetime Cancer Risk	Resident (Child) Absorbed Dose (mg/kg-day) (Nc)	Resident (Child) Absorbed Dose (mg/kg-day) (Car)	Resident (Child) Hazard Quotient	Resident (Child) Contribution to Lifetime Cancer Risk	Resident Total Lifetime Cancer Risk
Potassium	NA	NA	NA	2.57E+003									
Selenium	5.00E-003	NA	NA	2.10E+000									
Sodium	NA	NA	NA	5.78E+002									
Thallium	8.00E-005	NA	NA	2.30E+000									
Vanadium	1.82E-004	NA	NA	2.80E+001									
Zinc	3.00E-001	NA	NA	5.34E+002									
Total Hazard Quotient and Cancer Risk:							1E-003	1E-006			1E-002	3E-006	4.13E-006

Assumptions for Resident (Adult)

CF =	1E-006	kg/mg
BW =	70	kg
SA =	5,700	cm2
AF =	0.07	mg/cm2
EF =	350	days/year
ED =	24	years
AT (Nc) =	8,760	days
AT (Car) =	25,550	days

Assumptions for Resident (Child)

CF =	1E-006	kg/mg
BW =	15	kg
SA =	2,800	cm2
AF =	0.2	mg/cm2
EF =	350	days/year
ED =	6	years
AT (Nc) =	2,190	days
AT (Car) =	25,550	days

Note: Cells in this table were intentionally left blank due to a lack of toxicity data
NA= Information not available
Absorption factors are from EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual, Supplement Guidance Dermal Risk Assessment, 1999

Response to the Comments From the U.S. Environmental Protection Agency, Region II

Subject: Action Memorandum for the Miscellaneous Components Burial Site (SEAD-63)
Seneca Army Depot, Romulus, New York, dated July, 2001

Comments Dated: August 23, 2001

Date of Comment Response: October 31, 2001

USEPA REGION II:

1. Comment: Section 2.1, 2nd ¶, 2nd to last Sentence: This statement seems outdated.

   Response: We believe the comment refers to the sentence "The depot formerly employed approximately 1,000 civilian and military personnel." This sentence is valid. No change has been made to the text

2. Comment: Section 5.1.9, 1st Sentence: Replace the word remedial with removal.

   Response: The word remedial has been replaced with removal.

3. Comment: An exposure frequency of 14 days for SEAD-63 is not protective of public health. EPA proposed an exposure frequency based on 3 days/week during 13 summer weeks, and 1 day/week for the remaining 39 weeks of the year for a total exposure frequency of 78 days/year.

   Response: EPA's recommended exposure frequency as stated above has been considered for a recreational visitor (child). The recommended exposure frequency was directly used for exposure to soil, groundwater, and sediment. For exposure to surface water, we assumed wading events take place every time during 13 spring visits (when water is most likely to accumulate in the ditches) and 10% of other visits. Therefore, an exposure frequency of 20 days/yr was used for exposure to ditch water and sediment. This is a very conservative assumption because the ditch is usually dry except during storm periods. In addition, we used other conservative assumptions such as half of the total body surface being exposed during the wading event. The comparison of the human health risks presented in this report with the previously calculated risks are summarized in the attached table.

   All the risks calculated for the recreational child, park worker, and construction worker are within EPA's target risk ranges (i.e., 10^{-4} to 10^{-6} for lifetime cancer risk and 1 for non-cancer hazard risk) and therefore, are acceptable. The recreational child resulted in a hazard index of 0.4 and a cancer risk of 8E-5. The park worker resulted in a hazard index of 0.2 and a cancer risk of 5E-5. The primary constituents driving the cancer risk are dibenz(a,h)anthracene and benzo(a)pyrene in surface water. These two constituents were detected in only one sample out of 22 samples. Therefore, risk driven by these two constituents is most likely lower than indicated by the mini-risk assessment. In addition, the sediment of the ditch where dibenz(a,h)anthracene and benzo(a)pyrene were detected in the surface water is proposed to be excavated. Therefore, risks associated with the surface water due to the compounds will be addressed by the removal action.

In addition to addressing EPA's comments, we have updated our risk assessment of the dermal exposure route according to the USEPA's Dermal Risk Assessment Interim Guidance (1999), which represents the current knowledge of dermal risk assessment. The following major changes were included:

(1) We have updated soil dermal absorption factor according to the USEPA 1999 guidance. Risks associated with semivolatile organic compounds have been added to the risk evaluation by using a default value of 0.1 as the dermal absorption factor.

(2) The dermal RfD or cancer slope factor has been updated according to the USEPA's recommendations (1999).

(3) The permeability coefficient for compounds in water (Kp) and lag time per event (τ) have been updated.

(4) The RME values for soil and water dermal contact (e.g., skin surface area, soil adherence factor) have been updated according to the 1999 guidance.

We have also added residential risk evaluation backup calculations in Appendix F and updated table references in Table 2-15. The residential risk scenario was performed for comparison purposes only and was presented in the text of the earlier versions of this document.

Table 1, attached, compares the risk values in the July 2001 report and the updated risk values provided in this final version.

TABLE 1
Summary of Total Noncarcinogenic and Carcinogenic Risks
SEAD-63
Seneca Army Depot Activity

		Total Noncarcinogenic and Carcinogenic Risks			
		July, 2001 Report		**October, 2001 Report**	
RECEPTOR	**EXPOSURE ROUTE**	**HAZARD INDEX**	**CANCER RISK**	**HAZARD INDEX**	**CANCER RISK**
PARK WORKER	Inhalation of Dust in Ambient Air	7E-07	1E-09	7E-07	1E-09
	Ingestion of Soil	1E-03	5E-08	1E-03	5E-08
	Dermal Contact to Soil	4E-03	NQ	4E-04	8E-08
	Ingestion of Groundwater	1E-01	NQ	1E-01	NQ
	Dermal Contact to Surface Water	7E-03	9E-05	4E-03	5E-05
	Dermal Contact to Sediment	8E-04	1E-08	1E-03	1E-06
	TOTAL RECEPTOR RISK (Nc & Car)	**2E-01**	**9E-05**	**2E-01**	**5E-05**
RECREATIONAL VISITOR (CHILD)	Inhalation of Dust Ambient Air	3E-07	1E-10	1E-06	5E-10
	Ingestion of Soil	7E-04	8E-09	4E-03	4E-08
	Dermal Contact to Soil	7E-04	NQ	4E-04	2E-08
	Ingestion of Groundwater	5E-02	NQ	3E-01	NQ
	Dermal Contact to Groundwater	4E-03	NQ	5E-02	NQ
	Dermal Contact to Surface Water	3E-02	8E-05	4E-02	8E-05
	Dermal Contact to Sediment	3E-03	1E-08	1E-02	3E-06
	TOTAL RECEPTOR RISK (Nc & Car)	**9E-02**	**8E-05**	**4E-01**	**8E-05**
CONSTRUCTION WORKER	Inhalation of Dust in Ambient Air	9E-05	3E-08	9E-05	3E-08
	Ingestion of Soil	2E-01	4E-08	2E-01	4E-08
	Dermal Contact to Soil	3E-01	NQ	2E-02	1E-08
	TOTAL RECEPTOR RISK (Nc & Car)	**5E-01**	**8E-08**	**3E-01**	**9E-08**

NQ = Not Quantified due to lack of toxicity data.

ATTACHMENT B OF APPENDIX F

CHEMICAL PROFILES

NOTES ON THE PROFILES

(1) The physical and chemical properties described in the profiles impact fate and transport as follows:

Highly-soluble chemicals can be rapidly leached from wastes and soils and are generally mobile in groundwater. Solubilities can range from less than 1 mg/L to totally miscible, with most common organic chemicals falling between 1 mg/L and 1.000.000 mg/L [1]. The water solubility of chemicals may become enhanced in the presence of organic solvents, which may be of concern for mixed wastes.

Volatilization of a chemical from surface water will depend partly on its vapor pressure and water solubility. Highly water-soluble chemicals generally have lower volatilization rates from water unless they also have high vapor pressures. Vapor pressure, a relative measure of the volatility of chemicals in their pure state, ranges from roughly 0.001 to 760 millimeters of mercury (mm Hg) for liquids. The Henry's Law Constant, which combines vapor pressure with solubility, is more appropriate than vapor pressure alone for estimating releases from water to air. Chemicals with Henry's Law Constants greater than 10^{-3} atmospheres - cubic meter per mole (atm-m^3/mole) may readily volatilize from water, particularly if they have a density which is less than that for water and do not bind tightly to organic material. Chemicals with values ranging from 10^{-3} to 10^{-5} are associated with moderate volatilization, while chemicals with values less than 10^{-5} will only volatilize from water to a limited extent [1].

Specific gravity, as used in the profiles, refers to the ratio of the density of a given chemical to the density of pure water, normally at defined temperatures. An organic chemical present in groundwater with a density greater than the ambient water, which is present in an amount sufficient to form a separate phase, tends to sink to the lowest portions of the aquifer. Conversely, a chemical with a density less than the groundwater, which is present in an amount sufficient to form a separate phase, tends to spread out along the upper portions of the aquifer.

The organic carbon partition coefficient (K_{oc}) reflects the propensity of a chemical to sorb to organic matter found in soil. The normal range of K_{oc} values is 1 to 10^7 milliliters per gram (mL/g), with higher values indicating greater sorption potential. Chemicals which have a strong tendency to sorb to organic matter (i.e., chemicals with high K_{oc} values) will move more slowly in the environment than chemicals with low K_{oc} values.

(2) The half-life values included in the profiles are estimates based on abiotic and/or biotic degradation processes only, and do not account for the transport of a chemical between environmental compartments, unless otherwise specified [2]. Additionally, estimates are based on specified conditions such as soil type and chemical concentration. Therefore, the half-life ranges presented are not necessarily representative of a chemical's actual persistence within a particular environmental medium. The actual ranges of half-lives of chemicals which are mobile will probably be shorter than indicated in the case of permeable soils. Chemicals which are not mobile and are present at very high concentrations may actually have longer half-lives then indicated.

(3) A short half-life for degradation of a given chemical in a given medium does not guarantee that the health or environmental threat will be eliminated in a short period of time. It simply means that the chemical is likely to be modified within a relatively short time frame. The products of degradation vary tremendously, and some may be as toxic or more toxic than the starting material. A detailed description of the environmental degradation pathways for each chemical in each of the many types of media is beyond the scope of these profiles.

(4) Specific Gravity given at X/Y°C, where X = temperature of the chemical and Y = the temperature of the reference water.

(5) Abbreviations: NA = not applicable, ND = no data.

(6) There are no environmental half-life values for elements (metals) since they do not degrade.

(7) Abbreviations in Toxicity Section: RfD = oral reference dose; RfC = inhalation reference concentration; NOEL = no observed effect level; NOAEL = no observed adverse effect level; LOAEL = lowest observed adverse effect level; LEL = lowest effect level; FEL = frank effect level.

(8) The toxicity values presented were up-to-date at the time of preparation. However, current values should be obtained from the USEPA's Integrated Risk Information System (IRIS).

REFERENCES

1. Lyman, W.J., Rechl, W.G. and Rosenblatt, D.H., 1982. Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. McGraw Hill Book Company. New York.
2. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.

ACETONE

CAS NUMBER

67-64-1

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Miscible [1]
Vapor Pressure: 231 mm Hg at 25°C [1]
Henry's Law Constant: 3.67×10^{-5} atm-m^3/mole [1]
Specific Gravity: 0.788 at 25/25°C [2]
Organic Carbon Partition Coefficient: 0.28 [3]

FATE DATA: HALF-LIVES

Soil: 1 - 7 days [4]
Air: 11.6 - 116 days [4]
Surface Water: 1 - 7 days [4]
Groundwater: 2 - 14 days [4]

NATURAL SOURCES

Plants, animals, automobile exhaust, volcanoes, forest fires [1].

ARTIFICIAL SOURCES

Chemical industry, wood pulping, air pollution breakdown product, wood-burning fireplaces, tobacco smoke [1].

FATE AND TRANSPORT

Acetone evaporates rapidly from solid surfaces, but the miscibility of it retards losses from water. It is highly mobile in the soil/groundwater system, and that which does not volatilize from soil, will be readily dispersed in groundwater and carried to any downgradient discharge zones. Biodegradation occurs in soil, surface water, and groundwater. Adsorption to sediment and bioconcentration should not be significant. Acetone will be washed out of the atmosphere with rain [1,3,4].

HUMAN TOXICITY

General. Acetone acts primarily as an irritant and as a central nervous system depressant. Acetone is not considered to be mutagenic. The USEPA has placed acetone in weight-of-evidence cancer Group D,indicating that it is not classifiable as to human carcinogenicity [5].

Oral Exposure. A chronic chronic oral RfD of 0.1 mg/kg/day is based on a NOEL of 100 mg/kg/day for increased liver and kidney weights and nephrotoxicity in a subchronic oral study in rats [5]. Acetone is readily absorbed following oral exposure. Oral LD_{50} values in animals ranged from 3000 to 9750 mg/kg [3]. Fatal oral doses in humans have not been reported, but oral exposure to 200 ml (2860 mg/kg/day) acetone has resulted in gastroenteritis, narcosis and possible renal injury [3]. Information regarding the effects of acetone on human development are not available, but limited data in animals indicate that acetone is not a developmental toxicant [3]. There is no information regarding the carcinogenicity of acetone in humans or animals following oral exposure, therefore, an oral Slope Factor is not available [5,6].

Inhalation Exposure. A chronic inhalation RfC is not available for acetone [5,6]. Acetone is readily absorbed following inhalation exposure. Reported acute inhalation LC_{50} values are 110,000 mg/m^3 for 62 minutes in mice, and 50,100 mg/m^3 for 8 hours in rats [3]. Inhaled acetone has not been reported to be fatal to humans. Human exposure to concentrations of 250 to 1000 ppm acetone has resulted in irritation of the eyes, nose and throat. Exposure to higher levels may result in depression of the central nervous system and narcosis [3]. Long-term inhalation of acetone by humans has resulted in hyperemia (increase in blood) in the conjunctiva and pharynx), lung irritation, rough breathing, dizziness, headaches, insomnia and stomach pain [3]. Information regarding the effects of acetone on human development are not available, but limited data in animals indicate that acetone is not a developmental toxicant [3]. There is no information regarding the carcinogenicity of acetone in humans or animals following inhalation exposure, therefore, an inhalation Unit Risk factor is not available [5,6].

Dermal Exposure. An acute dermal LD_{50} value of 20,000 mg/kg has been reported in rabbits [3]. Dermal exposure to acetone has not been reported to be fatal to humans. Short-term (90 minutes) application of acetone to the skin of humans has resulted in mild edema and hyperemia of the skin [3]. Animal studies indicate that chronic dermal application of acetone may result in reversible cataracts in guinea pigs, but not rabbits [3].

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. II: Solvents. Lewis Publishers, Inc. Chelsea, Michigan. 546 pp.

2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.

3. Arthur D. Little, Inc., 1987. The Installation Restoration Program Toxicology Guide. Volume 3. Cambridge, MA. June 1987.

4. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko. 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.

5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

6. USEPA, 1994. Health and Environmental Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March, 1994.

ALDRIN/DIELDRIN

GENERAL

Aldrin and dieldrin are structurally similar man-made insecticides. Additionally, dieldrin is a breakdown product of aldrin, resulting from biodegradation. Aldrin is rapidly converted to dieldrin in the environment. Humans and animals exposed to aldrin metabolize it into dieldrin [1].

CAS NUMBERS

Aldrin	309-00-2
Dieldrin	60-57-1

COMMON SYNONYMS

Aldrin	HHDN
Dieldrin	HEOD

ANALYTICAL CLASSIFICATION

Pesticide (organic)

PHYSICAL AND CHEMICAL DATA

	Aldrin	Dieldrin
Water Solubility (mg/L at 20°C) [2]:	0.02	0.17
Vapor Pressure (mm Hg at 20°C) [2]:	3.75×10^{-5}	3.75×10^{-6}
Henry's Law Constant (atm-m^3/mole) [2]:	4.69×10^{-4}	5.8×10^{-5}
Specific Gravity [1]:	1.70 (at 20°C)	1.75 (at 25°C)
Organic Carbon Partition Coefficient [1]:	48,978	7,413

FATE DATA: HALF-LIVES

	Aldrin	Dieldrin
Soil: [3]	3 wk to 1.6 yr	175 da to 3 yr
Air: [3]	55 min to 9.1 hr	4 hr to 1.7 da
Surface Water: [3]	3 wk to 1.6 yr	175 da to 3 yr
Groundwater: [3]	1 da to 3.2 yr	1 da to 6 yr

NATURAL SOURCES

None noted [2].

ARTIFICIAL SOURCES

Insecticides: dieldrin is also an environmental degradation product of aldrin [2].

FATE AND TRANSPORT

Aldrin is no longer produced or used in the United States. Since it is readily converted to dieldrin in the environment, there should be relatively little left. Aldrin is considered to be moderately persistent. Biodegradation of aldrin should be slow and it should not leach to groundwaters. Photooxidation in water is significant. Reaction with hydroxyl radicals in air should be rapid.

Dieldrin is an extremely persistent compound. Releases of dieldrin to soils may persist for periods exceeding 7 years. The low water solubility and high K_{oc} values make leaching into groundwaters unlikely even over long periods of time at elevated temperatures. Soil runoff may carry particle-adsorbed dieldrin to the water system. Dieldrin in water systems will not undergo hydrolysis or appreciable biodegradation; photoarrangement to photodieldrin is a possibility. Adsorption to sediments/suspended solids in waters, and moderate to significant bioconcentration in aquatic organisms are predicted to be important transport/fate mechanisms. At low water flow conditions, the main "sink" for dieldrin in water systems will be the sediment (via desorption and pore water diffusion through sediments). Evaporation from waters may be an important process. Volatilization from soils, slight in any case, will increase as the moisture content of the soils increases. Dieldrin in the atmosphere is probably associated with particulate matter, given the low vapor pressure and high K_{oc} values of dieldrin, and may be transported over long distances. Vapor-phase dieldrin in the atmosphere may undergo photodegradation to photodieldrin although it is not expected to be an important process [2].

HUMAN TOXICITY

General. Aldrin and dieldrin are absorbed by oral, inhalation, and dermal routes of exposure. Exposure to very high levels of aldrin and/or dieldrin for a short time causes convulsions and/or kidney damage. Exposure to lower levels for a longer time may also cause convulsions. Human deaths following exposure have been documented [1]. The USEPA has placed both aldrin and dieldrin in weight-of-evidence Group B2, indicating that they are probable human carcinogens [4].

Oral Exposure. A chronic RfD for aldrin of 0.00003 mg/kg/day is based on a LOAEL of 0.025 mg/kg/day for liver toxicity in a chronic feeding study in rats. A chronic RfD of 0.00005 mg/kg/day for dieldrin is based on a NOAEL of 0.005 mg/kg/day for liver lesions in a chronic feeding study in rats [4]. Aldrin and dieldrin are absorbed from the gastrointestinal tract, but the rate and extent of absorption have not been fully characterized. Oral LD_{50} values in rats reportedly range from 39 to 60 mg/kg/day for aldrin, and 37 to 46 mg/kg/day for dieldrin, indicating a fairly high level of toxicity. Decreased survival in dogs exposed for 25 months was observed at a level of

1 mg/kg/day for aldrin, and a level of 0.5 mg/kg/day for dieldrin. Adverse central nervous system effects have been observed in humans and animals following oral exposure to aldrin and/or dieldrin. Several cases of aldrin and dieldrin poisoning in humans, including deaths, have been reported [1]. An oral slope factor of 17 $(mg/kg/day)^{-1}$ for aldrin is based on liver carcinomas observed in mice maintained on a treated diet. An oral slope factor of 16 $(mg/kg/day)^{-1}$ for dieldrin is based on liver carcinomas observed in mice maintained on a treated diet [4].

Inhalation Exposure. The USEPA does not currently provide inhalation RfCs for aldrin or dieldrin [4,5]. Although quantitative data are lacking, it appears that aldrin is readily absorbed in the mammalian lung. Central nervous system symptoms reported by workers involved in the manufacture and application of aldrin and/or dieldrin included headaches, dizziness, hyperirritability, general malaise, nausea and vomiting, anorexia, muscle twitching, and myoclonic jerking [1]. An inhalation unit risk of 0.0049 $(mg/m^3)^{-1}$ for aldrin was calculated based on the oral study. An inhalation unit risk of 0.0046 $(mg/m^3)^{-1}$ for dieldrin was calculated based on the oral study [4].

Dermal Exposure. Dermal absorption of aldrin and dieldrin in skin is rapid for rats, and appears to be rapid in humans as well. Central nervous system symptoms reported by workers involved in the manufacture and application of aldrin and/or dieldrin included headaches, dizziness, hyperirritability, general malaise, nausea and vomiting, anorexia, muscle twitching, and myoclonic jerking [1].

ECOLOGICAL TOXICITY

General. Both aldrin and dieldrin were developed and widely used as insecticides. As would be expected from this class of compounds, both chemicals have a high environmental toxicity for invertebrates and are also quite toxic to fish, birds, and mammals. They also shows strong tendencies for bioaccumulation, with bioconcentration factors on the order of 10^5 in fish tissue, ostracods, and snails; 10^3 in algae, freshwater vascular plants (*Elodea*), and clams; and 10^2 for crabs [6]. As a result, the use and manufacture of these chemicals has been prohibited in the United States since the 1970's.

Vegetation. In soils, aldrin is volatilized or slowly transformed to dieldrin. In studies reviewed by Micromedex, Inc. [7], the half-life of aldrin in soils was reported in one source to be from 20 to 100 days, while another source reported a 2- to 3-month half-life for the first half year, and 9 months to 13 months for the following 3 years. Although aldrin has some affinity for soil particles, it is not strongly adsorbed like many other organochlorines. It therefore is more bioavailable to plants than are many other members of this chemical group.

Sax [8] states that aldrin has no phytotoxicity to irrigable plants when it is used in the proper formulation. This appears to be demonstrated by studies that involved the application of a 5-percent solution of aldrin to *Viburnum lantana* (a woody shrub) with resulting injury to only 15 percent of the test species [9]. Corn seed soaked in aldrin at a rate of 2 ounces per bushel had a 40 percent decrease in germination [10].

Data summarized by Micromedex, Inc. [7] indicate that dieldrin in the environment is very persistent, having a half-life in soils of 7 years. Biodegradation and hydrolysis are unimportant processes, and losses occur only through slow photodegradation at the soil surface or the volatilization of small amounts from soil.

No data on the phytotoxicity of dieldrin were found. However, its widespread application to corn and other crops for many years without reports of decreased crop germination, growth, or yields indicates a low level of phytotoxicity. Dieldrin is strongly adsorbed to soils, and is immobile even with high temperatures and prolonged leaching [7]. As a result, this compound is not readily bioavailable for plant uptake.

Aquatic Life. The federal aquatic life criterion for dieldrin for the chronic protection of freshwater aquatic life is 0.0019 μg/L. The corresponding State of Ohio criterion for dieldrin is 0.005 μg/L. There is neither a federal nor a state standard for aldrin in freshwater aquatic systems.

Aldrin and dieldrin are highly toxic to aquatic invertebrates and fish. For example, studies cited in the USEPA "Red Book" [6] show 96-hour LC_{50}s (acute toxicities) of dieldrin for invertebrates of 0.2 μg/L to 0.3 μg/L. Micromedex, Inc. [7] shows 96-hour LC_{50}s of dieldrin for invertebrates ranging from 0.9 to 6,700 μg/L and most 96-hour LC_{50}s of aldrin for invertebrates between 1.3 μg/L and 50 μg/L. Dieldrin is acutely toxic to frog and toad tadpoles at 100 to 150 μg/L [7]. Acute toxicities to common freshwater fish species such as bluegill, trout, largemouth bass, and catfish typically range from 1 to 20 μg/l [6,7]. Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [6].

A major concern for aquatic life is the bioconcentration of dieldrin. (Aldrin has a negligible bioconcentrating effect because it is rapidly converted to dieldrin by aquatic organisms [6] Studies cited in the Red Book showed bioconcentration factors on the order of 10^5 in fish tissue, ostracods, and snails; 10^3 in algae, freshwater vascular plants (*Elodea*), and clams; and 10^2 for crabs [11].

Wildlife. Toxicity of aldrin and dieldrin to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents and dogs. The lethal dose of dieldrin by ingestion for mule deer was 75 mg/kg to 100 mg/kg [7]. Adverse effects on deer occurred with long-term feeding at 2 ppm dieldrin [6]. In the mammalian body, dieldrin accumulates chiefly in the adipose tissue where some bioconcentration occurs [8]. For example, in cattle and swine, the adipose tissue concentrations of dieldrin after 28 days were approximately twice the concentrations in the animals' feed [8].

Birds are also susceptible to aldrin and dieldrin poisoning. Studies summarized in Micromedex, Inc. [7] showed that ring-necked pheasant, bobwhite quail, Japanese quail, grey partridge, and house sparrows had 5-day LC_{50}s for ingestion of dieldrin ranging from 10 to 80 mg/kg. Waterfowl appeared to be more tolerant of this compound, with 5-day LC_{50}s of 100 to 380 mg/kg. Aldrin was toxic to bird species at concentrations ranging from 6 to 520 mg/kg. In long-term feeding studies, 1 ppm of dieldrin affected reproduction in Hungarian partridge, and slight eggshell thinning was noted in mallards fed 3 ppm dieldrin.

REFERENCES

1. ATSDR. 1991. Toxicological Profile for Aldrin/Dieldrin. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
2. Howard, P.H., 1991. Handbook of Environmental Fate and Exposure Data For Organic Chemicals. Vol. III: Pesticides. Lewis Publishers, Inc. Chelsea, MI. 684 pp.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko. 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. USEPA. 1995. Integrated Risk Information System (IRIS). On-line data base. March. 1995.
5. USEPA. 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
6. USEPA. 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
7. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.
8. Sax, N.I. (ed.). 1988. Aldrin. Dangerous Properties of Industrial Materials Report. Van Nostrand Reinhold, New York. Vol.8 (2): 23-39.
9. Clower, D.F. and J.G. Matthysse, 1954. Phytotoxicity of insecticides in mist concentrate type formulations. J. Econ. Ent. 47:735-738.
10. Grogan, C.O., 1959. Effect of fungicides and insecticides on the germination of corn after storage. Plant Dis. R. 43:1132-1137.
11. USEPA. 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I: Introduction and Technical Background, Metals and Inorganics,

Pesticides and PCB's. Office of Planning and Standards. Office of Water and Waste Management, Washington D.C. EPA-440/4-79-029a.

ALUMINUM

CAS NUMBER

7429-90-5

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble [1]

Vapor Pressure: insignificant at 25°C [1]

Henry's Law Constant: Not Applicable

Specific Gravity: 2.70 [1]

Organic Carbon Partition Coefficient: NR

BACKGROUND CONCENTRATIONS

Aluminum is a naturally-occurring element. The concentration of aluminum in minimally disturbed soils varies. A collection of 1.247 soil samples from across the conterminous U.S. determined that 79 percent were less than 70.000 ppm. with a geometric mean of 47.000 ppm and a maximum value of 100.000 ppm [2]. In water. aluminum concentrations are dependent upon the pH of the water: significant concentrations occur only when the pH is less than 5. In waters with a high humic-derived acid content. aluminum may be present even at a more neutral pH [1]. In surface water. aluminum was detected at concentrations ranging from 0.001 to 2.760 mg/L with a mean concentration of 0.074 mg/L in 456/1577 samples [1].

FATE AND TRANSPORT

The mobility of aluminum in the environment will be dependent upon the solubility of the aluminum compound and upon the pH of the environmental medium. Soluble compounds will tend to be more mobile in the environment and a lowering of the pH of the soil generally results in an increase in mobility for monomeric forms of aluminum. Consequently. acid rain may mobilize aluminum in the environment. Terrestrial plants take up aluminum. but it is not likely to bioconcentrate [1].

HUMAN TOXICITY

General. Aluminum is a major component of the earth's crust. People may be exposed to aluminum through its use in cooking utensils, antacids and antiperspirants. Aluminum in these forms has not been reported to be harmful, although excess exposure to aluminum is not beneficial and may be harmful to some people. Excess aluminum has been associated with neurodegenerative diseases, although the link between the two is tenuous. The primary targets of aluminum toxicity are the central nervous system, skeletal system, respiratory system and the developing fetus [1]. Aluminum is not known to cause cancer in humans or animals, and has not been placed in a USEPA weight-of-evidence cancer group [3].

Oral Exposure. A chronic oral RfD is not available for aluminum [3,4]. Oral LD_{50} values of 261 mg Al/mg body weight in rats (nitrate form) and 770 mg Al/kg in mice (chloride form) have been reported. In humans, aluminum has been associated with neurodegenerative diseases, such as Alzheimer's disease. A causal relationship, however, has not been shown between aluminum exposure and the progression of neurodegenerative disease. Neurodegenerative diseases have also developed in individuals who have been on renal dialysis for a number of years. Aluminum is present in the dialysis fluid and is given to control hyperphosphatemia. A softening of the bones, resulting in increased spontaneous fractures and pain, has been reported in dialysis patients. In infants given renal dialysis containing aluminum, aluminum accumulation and encephalopathy has been noted. The effects of aluminum on the developing fetus of animals have been controversial: a decrease in pup growth and neurological development have been observed in some studies, but not others [1].

Inhalation Exposure. An inhalation RfC is not available for aluminum [3,4]. Inhalation of aluminum results in irritive effects on the respiratory system, including asthma, cough, lung fibrosis and decreased pulmonary function [1].

Dermal Exposure. Dermal exposure to aluminum is primarily the result of the use of aluminum-containing antiperspirants. In sensitive individuals, aluminum may cause a skin rash [1].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Aluminum. Draft. Agency for Toxic Substances and Disease Registry. October, 1990.
2. USGS, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.

3. USEPA. 1995. Integrated Risk Information System (IRIS). Online. March. 1995.
4. USEPA. 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.

ANTIMONY

CAS NUMBER

7440-36-0

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble (elemental) [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: Density: 6.68 at 20/4°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATION

Pure antimony is a silver-white, lustrous, hard brittle metal. Antimony was detected (in measurable quantities) in 66 of 354 soils samples from across the conterminous United States [2]. The concentration of antimony in minimally disturbed soils shows limited variations, with a range from <1 ppm up to a maximum of 8.8 ppm, and an overall geometric mean of 0.48. Of the samples collected, 81 percent showed antimony concentrations to be less than 1 ppm [2]. Antimony was not detected in measurable quantities within the State of Ohio.

FATE AND TRANSPORT

Elemental antimony is relatively short-lived in the natural environment undergoing oxidation reactions to form antimony oxides and trihalides. Although not demonstrated, antimony may undergo biological methylation (forming organometals) as do those compounds surrounding it in the periodic table. Antimony oxides and trihalides are expected to volatilize readily, with $SbCl_3$ releasing HCl gas to the atmosphere when in the presence of moisture [1]. Antimony oxides are also expected to undergo photoreduction in aqueous environments. Organic antimony compounds are relatively mobile in all environments, while inorganic antimony compounds tend to be only slightly soluble or decompose in water [1]. Antimony, is not expected to bioconcentrate appreciably in fish or aquatic organisms [1].

HUMAN TOXICITY

General. The major targets of antimony toxicity are the respiratory system, the heart, the gastrointestinal system and the skin [1]. Antimony exposure, however, has beneficial as well as adverse effects. Antimony is currently used to treat two parasitic diseases, schistosomiasis and leishmaniasis. Side effects following treatment include altered EKG, anemia, vomiting, diarrhea, joint and/or muscle pain and even death [1]. Information regarding the genotoxicity of antimony is equivocal. Metallic antimony has not been placed in a weight-of-evidence cancer group by the USEPA [3].

Oral Exposure. A chronic oral RfD of 0.0004 mg Sb/kg/day is based on a LOAEL of 0.35 mg Sb/kg/day for longevity, decreased blood glucose levels and altered cholesterol levels in a chronic oral study in rats [3]. Antimony is poorly absorbed following oral exposure (<10%) [1]. Ingested antimony has not been reported to be fatal to humans, and acute oral LD_{50} values in animals are not available [1]. In humans, gastrointestinal effects have been reported following exposure to oral doses of 0.53 mg Sb/kg/day [1]. In animals, long-term oral exposure to > 0.07 mg Sb/kg/day resulted in effects similar to those reported in humans [1]. There is no evidence that ingested antimony results in developmental or reproductive effects or cancer in humans or animals [1]. An oral Slope Factor for cancer is not available for antimony [3].

Inhalation Exposure. An inhalation RfC for antimony is not available [3]. Antimony is absorbed following inhalation exposure, but the extent of absorption in humans is not known [1]. Inhaled antimony has not been reported to be fatal to humans, and acute inhalation LC_{50} values in animals are not available [1]. The effects of antimony in occupationally exposed workers include pneumoconiosis, altered EKG readings, increased blood pressure, abdominal distress, ulcers, dermatosis, and eye irritation [1]. These effects were generally observed following the inhalation of > 2 mg Sb/m^3 [3]. In animals, long-term inhalation exposure to concentrations > 0.05 mg Sb/m^3 resulted in effects similar to those reported in humans [1]. There is no conclusive evidence that inhaled antimony effects human reproduction or development, but problems with fertility were observed in animals exposed to high levels (209 mg Sb/m^3) of antimony for 9 weeks [1]. Information regarding the carcinogenicity of inhaled antimony in humans is not available, but studies in animals indicate that inhaled antimony may cause lung cancer [1]. An inhalation Unit Risk for cancer is not available for antimony [3].

Dermal Exposure. Dermal exposure to antimony has not been reported to be fatal to humans, and acute dermal LD_{50} values in animals are not available [1]. Antimony is not a skin sensitizer in humans, but animal studies have shown that antimony is a skin and eye irritant [1].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Antimony (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.
2. USGS, 1984. Elemental Concentrations in Soils and Other Surficial Material of the Conterminous United States. United States Geological Survey Professional Paper 1270, U.S. Department of the Interior. United States Government Printing Office, Washington, D.C. 105 pp.
3. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

ARSENIC

CAS NUMBER

7440-38-2

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 5.727 at 25/5°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Arsenic is a naturally-occurring element. The concentration of arsenic in minimally disturbed soils varies tremendously. A collection of 1,257 soil samples from across the conterminous U.S. determined that 90 percent were less than or equal to 10 ppm, with a geometric mean of 5.2 ppm, but with a maximum value as high as 100 ppm. Of fifteen samples collected around Ohio, 73 percent were found to contain arsenic at concentrations less than or equal to 10 ppm, with a maximum value between 10 and 100 ppm [3].

FATE AND TRANSPORT

Elemental arsenic is extremely persistent in both water and soil. Environmental fate processes may transform one arsenic compound to another; however, arsenic itself is not degraded. Soluble forms of arsenic tend to be quite mobile in water, while less soluble species adsorb to clay or soil particles. Microorganisms in soils, sediments, and water can reduce and methylate arsenic to yield methyl arsines, which volatilize and enter the atmosphere. These forms then undergo oxidation to become methyl arsonic acids and are ultimately transformed back to inorganic arsenic [1].

Bioconcentration of arsenic occurs in aquatic organisms, primarily in algae and lower invertebrates. Biomagnification in aquatic food chains does not appear to be significant, although some fish and invertebrates contain high levels of arsenic compounds which are relatively inert toxicologically. Plants may accumulate arsenic, subject to various factors including soil arsenic concentration, plant type, and soil characteristics [1].

HUMAN TOXICITY

General. Arsenic is a long-recognized human poison capable of producing a lethal reaction and cancer. The major targets of arsenic toxicity are the respiratory system, gastrointestinal system, nervous system, hematological system and skin [1]. Studies in animals suggest that low levels of arsenic may be necessary to maintain good health, but this has not been shown in humans [1]. Arsenic is considered a weak mutagen and has been placed in weight-of-evidence cancer Group A, indicating that it is a human carcinogen [4].

Oral Exposure. A chronic oral RfD of 0.0003 mg As/kg/day is based on a NOAEL of 0.0008 mg As/kg/day for hyperpigmentation, keratosis and possible vascular complications in a chronic oral study in humans [4]. Arsenic is readily absorbed following oral exposure. Acute oral LD_{50} values of 26 mg/kg for mice and 15 to 110 mg/kg for rats are reported [1]. The fatal dose in humans is estimated to be 2 mg/kg [1]. Low-level oral exposure (> 0.01 mg As/kg/day) may cause irritation of the digestive tract, pain, nausea, vomiting, diarrhea, skin abnormalities, decreased production of blood cells, abnormal heart function, blood-vessel damage, liver damage, kidney damage, and impaired nerve function ("pins and needles" sensation). In animal studies, high doses of arsenic (> 14 mg As/kg/day) have resulted in effects on the developing fetus. These effects have not been observed in humans [1]. In humans, chronic, oral exposure to low doses of arsenic (> 0.01 mg As/kg/day) has been shown to cause cancer of the skin, liver, bladder, and lung. The most characteristic effect of long-term oral exposure to arsenic is a darkening of the torso and the appearance of small "corns" or "warts" on the palms, soles and torso. These "corns" or "warts" may develop into skin cancer [1]. An oral Unit Risk of 0.00005 $(\text{ug As/L})^{-1}$ [1.75 $(\text{mg/kg/day})^{-1}$] has recently been adopted by the USEPA [4]. The Unit Risk is based on the increased incidence of skin cancer in humans exposed to arsenic in the drinking water.

Inhalation Exposure. An inhalation RfC is not available for inorganic arsenic [4]. Approximately 40% of an inhaled concentration of arsenic is absorbed [1]. Inhalation of arsenic has not been reported to be fatal in humans, and acute inhalation LC_{50} values are not available [1]. Inhalation of arsenic at concentrations greater than 0.1 mg As/m^3 may result in irritation of the nose and throat, leading to laryngitis, bronchitis or rhinitis [1]. Effects on the skin, nervous system, and gastrointestinal system similar to those found following oral exposure have been observed in humans following inhalation exposure. Of much greater concern, however, is that inhaled arsenic has been found to increase the risk of lung cancer in humans [1]. An inhalation Unit Risk of 0.0043 $(\text{ug As/m}^3)^{-1}$ was derived by USEPA [4] based on the increased incidence of lung cancer in occupationally exposed workers. Several epidemiology studies have suggested an association between arsenic inhalation and an increased risk of developmental effects (congenital malformations, low birth weight, spontaneous abortion) [1]. Studies in animals support the view that arsenic is a developmental toxicant, but only at high doses (20 mg/m^3) [1].

Dermal Exposure. Arsenic has not been reported to be fatal following dermal contact [1]. Dermal contact with arsenic may result in mild to severe irritation of the skin and mucous membranes and could lead to dermal sensitization [1].

ECOLOGICAL TOXICITY

General. Arsenic is a relatively common element that is present in air, water, soil, plants, and all living tissues. At comparatively low doses, arsenic stimulates growth and development in various species of plants and animals [5]. Arsenic exists in the trivalent (III) and pentavalent (V) states, and its compounds may be either organic or inorganic [6]. Inorganic arsenic compounds are more toxic than organic compounds [5]. Background concentrations of arsenic in unpolluted river waters and soils in the United States are usually <5 μg/L and <15 mg/kg dry weight, respectively [5]. Arsenic is bioconcentrated by organisms, but does not biomagnify in the food chain.

Vegetation. There is no evidence that arsenic is essential for plant growth [7]. Elemental arsenic is considered to be relatively nontoxic to plants [8]. In plants, arsenic concentrations vary between 0.01 and 1.0 ppm. Plants grown in soils contaminated with arsenic do not show higher concentrations of this element than plants grown on uncontaminated soil [7]. In cases of arsenic toxicity, the roots are usually severely affected and plant growth is limited before large amounts of arsenic are absorbed and translocated [8]. Arsenic in soils is most toxic to plants at the seedling stage where it limits germination and reduces viability [7]. The concentration of arsenic that is toxic to plants was determined to be >10 ppm by the National Academy of Sciences [9].

Aquatic Life. Arsenic is toxic to aquatic organisms within the range of 1.0 to 45.0 mg/L arsenite, which is considered more toxic than arsenate [8]. Arsenic is extremely mobile in the aquatic environment, and its fate depends largely on prevailing pH and Eh conditions [10]. Normal arsenic concentrations in fish are 0.52 ppm for bluegill and 0.14 to 1.95 ppm for minnows [9].

Arsenic can bioaccumulate in aquatic vertebrates and invertebrates from water and food, but concentration factors are relatively low [5,11]. The BCF of inorganic arsenic in most invertebrates and fish exposed for 21 to 30 days did not exceed 17 [5]. The biological half-lives of arsenic in green sunfish and bluegills are 7 days and 1 day, respectively [11]. The lethal threshold of arsenic for minnows has been reported to be 234 mg/L [6].

Micromedex. Inc. [12] reported the 36-hour toxic value for minnows was 11.6 ppm and the 16-hour toxic value was 60 ppm.

The USEPA acute freshwater criterion for arsenic (V) is 850 μg/L and because there is insufficient data to develop the criteria, the value presented is the LOEL. The acute freshwater criterion for arsenic (III) is 360 μg/L, and the chronic freshwater criterion for the trivalent form is 190 μg/L [13]. The Ohio chronic aquatic life water quality criterion for arsenic is 190 μg/L based on warmwater and modified warmwater habitats [14].

Wildlife. Chronic poisoning is infrequently seen in most animals because detoxication and excretion are rapid [5]. Normal arsenic concentrations in mice are 1.0 ppm, while hawks typically have body burdens of 0.4 ppm [9]. Adverse effects were noted in mammals at single oral doses of 2.5 to 33 mg/kg body weight and at chronic oral doses of 1 to 10 mg/kg body weight [5]. Acute waterfowl toxicity is reported at 0.05 ppm [12]. Median lethal concentrations in the diets of mallards were reported at 5,000 ppm [15]. The oral LD_{50} values are 15 mg/kg body weight for rats, 25 to 47 mg/kg body weight for mice, 4 to 19 mg/kg body weight for rabbits, and 6.5 mg/kg body weight for fowl [12]. Arsenic does not accumulate in mammals [8].

REFERENCES

1. ATSDR. 1991. Toxicological Profile for Arsenic (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October. 1991.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. USGS. 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
4. USEPA. 1995. Integrated Risk Information System (IRIS). Data base. Online. March. 1995.
5. Eisler, R., 1988. Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews, Report 12, Biological Report 85 (1.12). U.S. Department of the Interior, Fish and Wildlife Service. Washington, D.C.
6. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
7. USEPA, 1983. Hazardous Waste Land Treatment. (Revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
8. U.S. Fish and Wildlife Service, 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitats. FWS/OBS-78/29.
9. National Academy of Sciences, 1977. Arsenic. Committee on Medical and Biological Effects of Environmental Pollutants. Washington. D.C.

10. USEPA. 1979. Water-Related Environmental Fate 129 Priority Pollutants. Volume 1. Office of Water and Waste Management. Washington, D.C. EPA-440/4-79-029.

11. Phillips, G.R. and R.C. Russo. 1978. Metal Bioaccumulation in Fishes and Aquatic Invertebrates: A Literature Review. USEPA. Office of Research and Development. Duluth, Minnesota. EPA-600/3-78-103.

12. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.

13. USEPA. 1991. Water Quality Criteria Summary. Washington, D.C.

14. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code. Title 3745-Chapter 1. Ohio Environmental Protection Agency.

15. CH2M Hill, Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver. Colorado.

BARIUM

CAS NUMBER

7440-39-3

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: decomposes [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 3.51 at 20/20°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Barium is a naturally-occurring element. The concentration of barium in minimally disturbed soils varies tremendously. A collection of 1.319 soil samples from across the conterminous U.S. determined that 86 percent were less than or equal to 700 ppm. with a geometric mean of 440 ppm. but with a maximum value as high as 3.000 ppm. Of fifteen samples collected around Ohio. 80 percent were found to contain barium at concentrations less than or equal to 500 ppm. with a maximum value between 500 and 700 ppm [2].

FATE AND TRANSPORT

Barium is a highly reactive metal that occurs naturally only in the combined state. Most barium released to the environment from industrial sources is in forms that do not become widely dispersed. In the atmosphere. barium is likely to be present in the particulate form. Environmental fate processes may transform one barium compound to another; however. barium itself is not degraded. It is removed from the atmosphere primarily by wet or dry deposition [1].

In aquatic media. barium is likely to precipitate out of solution as an insoluble salt. or adsorb to suspended particulate matter. Sedimentation of suspended solids removes a large portion of the barium from surface waters. Barium in sediments is found largely in the form of barium sulfate. Bioconcentration in freshwater aquatic organisms is minimal [1].

Barium in soil may either be taken up to a small extent by vegetation, or transported through soil with precipitation. Barium is not very mobile in most soil systems. The higher the level of organic matter, the greater the adsorption. The presence of calcium carbonate will also limit mobility. Mobility is increased in the presence of high chloride concentrations. Barium complexes with fatty acids, for example, in acidic landfill leachate, will be much more mobile [1].

HUMAN TOXICITY

General. The primary target of barium toxicity is the cardiovascular system [1]. Information regarding the genotoxicity of barium are equivocal. Barium has not been place in a weight-of-evidence cancer group by the USEPA [3].

Oral Exposure. A chronic oral RfD of 0.07 mg Ba/kg/day is based on a NOAEL of 0.21 mg Ba/kg/day for increased blood pressure in a long-term drinking water study in humans [3]. Barium is poorly absorbed following oral exposure (about 5%) [1]. In rats, acute oral LD_{50} values range from 132 to 277 mg/kg [1]. In humans, ingestion of very large amounts of barium (doses not reported) over a short period may cause paralysis or death. Ingestion of lower doses of barium over a short period may result in difficulties in breathing, increased blood pressure, changes in heart rhythm, stomach irritation, minor changes in blood, muscle weakness, changes in nerve reflexes, swelling of the brain, and damage to the liver, kidney, heart, and spleen [1]. Studies in animals report effects similar to those found in humans. Barium sulfate is sometimes given orally or rectally for the purpose of making X rays. This has not been shown to be harmful [1]. There is no evidence that oral exposure to barium affects human reproduction or development and developmental and reproduction studies in animals are inconclusive [1]. Barium has not been shown to cause cancer in humans or animals following oral exposure, therefore, an oral slope factor is not available [1,3].

Inhalation Exposure. A chronic inhalation RfC of 0.0005 mg/m^3 is based on a NOEL of 0.8 mg/m^3 for fetotoxicity in rats [4]. Approximately 65% of an inhaled concentration of barium is absorbed following inhalation exposure [1]. Barium has not been reported to be fatal to humans or animals following inhalation exposure [1]. Studies examining the toxicity of inhaled barium in humans and animals are extremely limited but suggest that exposure results in effects on the respiratory, cardiovascular, and gastrointestinal systems [1]. There is no evidence that inhaled barium affects human reproduction or development, but studies in animals suggest that barium may have adverse effects on these processes [1]. Barium is not known to cause cancer in humans or animals following inhalation exposure, therefore, an inhalation unit risk is not available [1,3].

Dermal Exposure. Dermal exposure to barium has not been reported to be fatal in humans or animals. Limited animal studies indicate that barium is a dermal and ocular irritant, but the results of this study are inconclusive [1].

ECOLOGICAL TOXICITY

General. Barium compounds are generally insoluble making them relatively unavailable for biological uptake [5]. All water- or acid-soluble barium compounds are poisonous. Barium is considered a nonessential element for plants and animals.

Vegetation. There are very few reports of barium toxicity to plants, except under conditions of acidic soils or with highly concentrated soil solutions where the bioavailable fractions are excessive (e.g., 2 mg/L soluble barium). Some authors report that concentrations of barium need to be extreme before toxicity occurs. Barium accumulation in plants is unusual except when the barium concentration exceeds calcium and magnesium concentrations in the soil, a condition which may occur when sulfate is depleted [6].

Aquatic Life. Barium ions in general are rapidly precipitated or removed from solution by chemical bonding, adsorption, and sedimentation. In most natural water, there is sufficient sulfate or carbonate to precipitate soluble barium present in the water, converting it to an insoluble nontoxic compound [6]. Experimental data indicate that soluble barium concentrations would have to exceed 50,000 μg/L before toxic effects to aquatic life might be observed [5]. Other data show the concentrations of barium lethal to half the test population of fish range from 150 to 10,000 mg/L [7]. Because barium represents little hazard under natural conditions, there are no federal or Ohio aquatic life water quality standards [8,9].

Wildlife. Soluble barium compounds such as barium chloride, barium carbonate, barium sulfide, and barium oxide are highly toxic to animals when ingested [10], although it is unlikely that suitable conditions would exist under natural conditions to accommodate exposure to these compounds. No reports of barium toxicity to wildlife under natural conditions were identified.

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Barium. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.
2. USGS, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
3. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

4. USEPA. 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
5. CH2M Hill. Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver, Colorado.
6. USEPA, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
7. Snyder, B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Serve. FWS/OBS-84/01.
8. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
9. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code. Title 3745-Chapter 1. Ohio Environmental Protection Agency.
10. U.S. Fish and Wildlife Service. 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitats. FWS/OBS-78/29.

BENZENE

CAS NUMBER

71-43-2

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1,791 mg/L [1]
Vapor Pressure: 95.19 mm Hg at 25°C [1]
Henry's Law Constant: 5.43 x 10^{-3} atm-m^3/mole (temperature not given) [1]
Specific Gravity: 0.879 at 15/5°C [2]
Organic Carbon Partition Coefficient: 31 - 143 [1]

FATE DATA: HALF-LIVES

Soil: 5 - 16 days [3]
Air: 2.09 - 20.9 days [3]
Surface Water: 5 - 16 days [3]
Groundwater: 10 days to 2 years [3]

NATURAL SOURCES

Crude oil, volcanoes, forest fires, plants [1].

ARTIFICIAL SOURCES

Gasoline, fuel oils, chemical industry, coke ovens, mining, manufacturing, cigarette smoke [1].

FATE AND TRANSPORT

Benzene will rapidly volatilize from surface soil and water. That which does not volatilize from permeable surface and subsurface soils will be highly to very highly mobile, and can be expected to leach to nearby groundwater which is not protected by a confining layer. It is fairly soluble, and will be carried with the groundwater to discharge points. It may be subject to biodegradation in soils, shallow groundwater, and surface water. Benzene will not be expected to significantly adsorb to sediment, bioconcentrate in aquatic organisms, or hydrolyze. Photodegradation may be a significant removal mechanism in surface waters which are not conducive to microbial degradation. Benzene will undergo significant photodegradation in air, but may be washed out with rain [1].

HUMAN TOXICITY

General. Benzene is absorbed into the body following ingestion, inhalation, and dermal contact, and must undergo metabolic transformation to exert its toxic effects. Metabolism occurs primarily in the liver, and to a lesser extent in the bone marrow [4]. The primary targets of benzene toxicity are the central nervous system and the blood [4,5]. Benzene is genotoxic to humans and the USEPA has placed it in weight-of-evidence cancer Group A, indicating that it is a human carcinogen [6].

Oral Exposure. A chronic oral RfD for benzene is currently under review by the USEPA [6]. Benzene is readily absorbed following oral exposure. The lowest reported fatal dose in humans is 50 mg/kg [5]. Acute oral LD_{50} values in animals include 930 to 5600 mg/kg in rats, 2000 mg/kg in dogs and 4700 mg/kg in mice [4,5]. Data regarding the ingestion of benzene in humans are limited to acute overexposure. Ingestion of 2 ml (29 mg/kg) has resulted in depression of the central nervous system, while ingestion of 10 ml (143 mg/kg) has been fatal [5]. The cause of death was usually respiratory arrest, central nervous system depression or cardiac collapse [4]. In animals, longer-term oral exposure has resulted in toxic effects on the blood (cytopenia: decrease in various cellular elements of the blood) and the immunological system (decreased white blood cells) [4]. There is no evidence that oral exposure to benzene causes effects on reproduction and development, but studies in animals suggest that benzene may affect fetal development [4]. There is no information regarding carcinogenic effects in humans following oral exposure to benzene, but studies in animals indicate that benzene ingestion causes cancer in various regions of the body [4]. An oral Slope Factor of 0.029 $(mg/kg/day)^{-1}$ is based on an increase in the incidence of leukemia in occupationally-exposed workers [6]. The oral Slope Factor was extrapolated from the inhalation data.

Inhalation Exposure. A chronic inhalation RfC for benzene is currently under review by the USEPA [6]. Benzene is readily absorbed following inhalation exposure. The lowest reported fatal concentration in humans is 6380 mg/m^3 for a 5 minute exposure [5]. Acute inhalation LC_{50} values in rats ranged from 10,000 ppm for 7 hours to 13,700 ppm for 4 hours [4,5]. Most of the available data regarding benzene exposure involve workers exposed in the workplace. The acute effects of benzene exposure involve the central nervous system. Brief exposure to concentrations of 700 to 3000 ppm can cause drowsiness, dizziness, headaches and unconsciousness, and exposure to concentrations of 10,000 to 20,000 ppm can result in death [4]. In most cases, the effects will end when exposure ceases. The hematopoietic system is the primary target of toxicity following long-term exposure: exposure for several months to years results in pancytopenia (reduction in red blood cells, platelets and white blood cells), while continued exposure for many years results in anemia or leukemia. The lowest concentration resulting in the hematological effects is approximately 10 to 50 ppm [5]. Benzene has been shown to cause chromosomal aberrations in bone marrow and lymphocytes in workers exposed to concentrations > 100 ppm [5]. Chromosomal damage has been found in animals at concentrations as low as 1 ppm [5]. Benzene is not known to be teratogenic (cause birth defects) in humans, but has been found to cause various problems in the developing fetus of animals (low birth weight, delayed bone formation) [4,5]. Occupational exposure to benzene has resulted in leukemia in exposed workers [4,5]. An inhalation Unit Risk of 8.3×10^{-6} $(ug/m^3)^{-1}$ is based on the incidence of leukemia in occupationally-exposed workers [6].

Dermal Exposure. Dermal exposure to benzene may cause redness and dermatitis [4,5]. Systemic effects have not been reported following dermal exposure to benzene.

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. II: Solvents. Lewis Publishers, Inc. Chelsea, Michigan. 546 pp.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko. 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. ATSDR, 1991. Toxicological Profile for Benzene (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
5. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide. Volume 2. Cambridge, MA. July 1989.
6. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

BERYLLIUM

CAS NUMBER

7440-41-7

COMMON SYNONYMS

Glucinium.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 1.848 20/4°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATION

Beryllium is a naturally-occurring element. The concentration of beryllium in minimally disturbed soils varies tremendously. A collection of 1303 soil samples from across the counterminous U.S. determined that 86 percent were less than 2 ppm. with a geometric mean of 0.63 ppm and a maximum value of 15 ppm. Sixteen soils samples were gathered in (or on a shared border of) Ohio; ten of these samples showed concentrations <1 ppm. four showed concentrations from 1.0 ppm to <2.0 ppm. and two showed concentrations exceeding 2.0 ppm (no data on maximum value within Ohio) [3].

FATE AND TRANSPORT

Pure beryllium is a gray metal. resistant to attack by acids (due to formation of a thin oxide film). In nature. beryllium is present in much greater concentrations in soils and sediments than in water. Beryllium is tightly adsorbed to most types of soils because it displaces divalent cations that share common sorption sites. Consequently, beryllium has limited mobility in soil and is not likely to leach to groundwater. Beryllium will not volatilize from water or soil. In water, beryllium compounds may hydrolyze to form other beryllium compounds. In air, beryllium will probably be in the form of beryllium oxide. It is not known if beryllium will be transformed to more soluble compounds. which will be removed via precipitation. Bioconcentration of beryllium in aquatic organisms will not be significant [1].

HUMAN TOXICITY

General. The major target of beryllium toxicity is the respiratory system [1]. Information regarding the mutagenicity of beryllium are mixed. Beryllium has been placed in weight-of-evidence Group B2, indicating that it is a probable human carcinogen [4].

Oral Exposure. A chronic oral RfD of 0.005 mg Be/kg/day is based on a NOAEL of 0.54 mg Be/kg/day for no adverse effects in a chronic oral study in rats [4]. Beryllium is poorly absorbed following oral exposure. Information regarding the effects of oral exposure in humans are not available and animal studies are limited. Acute oral LD_{50} values in rodents ranged from 18 to 200 mg Be/kg/day [1]. Rats fed a diet containing high levels of beryllium (>10 mg Be/kg/day) developed rickets. When the diet is deficient in calcium, beryllium will substitute for calcium in the bone, resulting in rickets; it is not known if this effect will occur in humans [1]. Information regarding the potential effects of ingested beryllium on reproduction and development in humans and animals are not available. There is no evidence that ingested beryllium causes cancer in humans, but animal studies suggest that beryllium may be carcinogenic following oral exposure [1]. An oral Slope Factor of 4.3 $(mg/kg/day)^{-1}$ has been derived based on an increase in the incidence of gross tumors at various sites in rats [4].

Inhalation Exposure. An inhalation RfC for beryllium is not available [4,5]. Beryllium is absorbed following inhalation exposure, but the extent of absorption is not known. Acute, 4-hour inhalation LC_{50} values in animals were 0.15 to 0.86 mg/m^3 in rats and 4.02 mg/m^3 in guinea pigs [1]. Occupational exposure of humans to beryllium dusts, including both inhalation and dermal exposure, is the primary route of beryllium exposure. The respiratory system is the target of beryllium toxicity following both acute and chronic exposure. Short-term exposure results a condition called chemical pneumonitis, which is characterized by cough, a burning in the chest, shortness of breath, anorexia and increasing fatigue. These effects are associated with concentrations > 0.1 mg Be/m^3 [1]. Chronic exposure to beryllium results in a condition known as berylliosis, or chronic beryllium disease, which is characterized by the presence of granulomas, fibrosis and emphysema in the lungs. Berylliosis has been found to occur at concentrations > 0.001 mg/m^3 [1]. The chemical pneumonitis occurs primarily with exposure to soluble beryllium compounds, while the berylliosis results primarily from exposure to insoluble beryllium compounds. Both conditions may be fatal. Effects on the heart, liver and kidney may also occur, but are probably secondary to the respiratory effects. There is no evidence that inhaled beryllium will cause developmental effects in humans, but studies in animals indicate that intratracheal exposure to beryllium may result in developmental effects [1]. Lung cancer has also been found in occupationally exposed workers [1]. An inhalation Unit Risk of 0.0024 $(ug/m^3)^{-1}$ has been derived based on an increase in the incidence of lung tumors in humans [4].

Dermal Exposure. Dermal exposure to beryllium has not been reported to be fatal to humans or animals. Dermal exposure to beryllium may result in allergic reactions in both humans and animals [1]. Skin granulomas (non-cancerous growths) may form on the skin of sensitized individuals [1].

REFERENCES

1. ATSDR, 1991. Toxicological Profile for Beryllium (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October, 1991.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. USGS, 1984. Elemental Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1720, U.S. Department of the Interior. United States Government Printing Office, Washington, D.C. 105 pp.
4. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
5. USEPA, 1994. Health and Environmental Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March, 1994.

BIS(2-ETHYLHEXYL)PHTHALATE

CAS NUMBER

117-81-7

COMMON SYNONYMS

1,2-Benzenedicarboxylic acid bis(2-ethylhexyl)ester; di(2-ethylhexyl) phthalate; dioctylphthalate.

ANALYTICAL CLASSIFICATION

Semi-volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.3 mg/L at 25°C [1]
Vapor Pressure: 6.45×10^{-6} mm Hg at 25°C [1]
Henry's Law Constant: 1.1×10^{-5} atm-m^3/mole [1]
Specific Gravity: 0.99 at 20/20°C [2]
Organic Carbon Partition Coefficient: 10,000 - 100,000 [1]

FATE DATA: HALF-LIVES

Soil: 5 - 23 days [3]
Air: 2.9 - 29 hours [3]
Surface Water: 5 - 23 days [3]
Groundwater: 10 - 389 days [3]

NATURAL SOURCES

Possible product of animal and/or plant life.

ARTIFICIAL SOURCES

Plasticizer for polyvinylchloride and other polymers: disposal/incineration of plastic(s)/polymer(s) [1].

FATE AND TRANSPORT

Bis(2-ethylhexyl)phthalate (hereafter, BEHP) has a strong tendency to adsorb to soils and sediments, suggesting low likelihood of leaching to groundwaters. Given the very low vapor pressure and Henry's Law constant of BEHP, volatilization from soils and waters is very unlikely. This compound does show a tendency to bioconcentrate in aquatic organisms. Hydrolysis (from aquatic systems), photolysis (in the water and atmosphere), and photo-oxidation (in atmospheric systems) are not predicted to be important removal processes. In aquatic environments, aerobic biodegradation occurs rapidly following acclimation; no anaerobic biodegradation occurs. Some slight biodegradation in soils is expected. In the atmosphere, the primary removal mechanism is via rainfall washout [1].

HUMAN TOXICITY

General. There is currently no evidence that BEHP causes adverse effects in humans, but animal studies indicate that the liver, kidneys and testes are targets of oral exposure [4]. Information regarding the genotoxicity of BEHP are equivocal but indicate that BEHP may act as a co-carcinogen in rodents [4]. The USEPA has placed BEHP in weight-of-evidence cancer Group B2, indicating that it is a probable human carcinogen [5].

Oral Exposure. A chronic oral RfD of 0.02 mg/kg/day is based on a LOAEL of 19 mg/kg/day for increased relative liver weight in a chronic oral study in guinea pigs [5]. BEHP is readily absorbed following oral exposure. Acute oral LD_{50} values of 30,600 mg/kg and 33,900 mg/kg have been defined for rats and rabbits, respectively [4]. BEHP has not been found to be fatal to humans at doses up to 143 mg/kg; mild abdominal pain and diarrhea were the only effects reported at this dose [4]. Oral studies in animals reported effects on the liver (morphological changes, nodules, tumors), kidneys (effects on kidney cells), thyroid and pancreas (changes in the acinar cells of both organs), and testes (atrophy and degeneration). Animal studies indicated that monkeys are less susceptible to the toxic effects of BEHP than are mice and rats [4]. The relative susceptibility of humans is not known. Effects on fetal development (reduced survival, malformations) were reported in rodents following oral exposure [4]. There is no evidence that BEHP causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [4]. An oral slope factor of 0.014 $(mg/kg/day)^{-1}$ is based on the incidence of liver tumors in mice [5].

Inhalation Exposure. An inhalation RfC is not available for BEHP [5]. Information regarding the toxicity of inhaled BEHP in humans are not available and data in animals are limited to one developmental study [4]. In the developmental study, no adverse effects were reported in rats following exposure to up to 300 mg/m^3 during gestation [4]. There is no evidence that inhaled BEHP causes cancer in humans or animals, therefore, an inhalation unit risk for cancer is not available for BEHP [5].

Dermal Exposure. An acute dermal LD_{50} value of 24,750 mg/kg was reported for rabbits [4]. Dermal exposure of both humans and animals indicate that BEHP is neither an irritant nor a sensitizer [4].

ECOLOGICAL TOXICITY

General. Bis(2-ethylhexyl)phthalate (BEHP) is the most well studied of the phthalate esters. Most information reported in the technical literature dealt with phthalate esters as a group. Autian [6] suggests there is evidence phthalate esters are degraded by microbiota and metabolized by fish and animals. As a result, phthalate esters are not likely to biomagnify.

According to Arthur D. Little, Inc. [7], phthalate esters readily complex with natural organic substances (e.g., fulvic acid) to form complexes which are very soluble in water. BEHP is nonvolatile, strongly adsorbed, and has a high potential for bioaccumulation.

Vegetation. Review of the technical literature did not produce information regarding the phytotoxic effects of BEHP.

Aquatic Life. Bioconcentration factors (BCFs) for fish and aquatic invertebrates range from 54 to 2,680. Fathead minnows accumulated levels of BEHP 1,380 times the water concentration of 2.5 μg/L after 28 days. Residue half-life was 7 days. Invertebrates accumulated BEHP up to 13,400 times when exposed to water concentrations ranging from 0.08 to 0.3 μg/L. Over 90 percent of the residues were lost within 10 days [8]. The 96-hour LC_{50} of bluegill is more than 770,000 μg/L [9]. The LC_{50} of *Daphnia magna* exposed to BEHP was 11,000 μg/L. There are no USEPA acute or chronic aquatic life criteria for BEHP [10]. The Ohio aquatic life chronic water quality criterion is 8.4 μg/L in warmwater and modified warmwater habitats [11].

Wildlife. The only information available on wildlife toxicity to BEHP concerns laboratory animals. The oral LD_{50} values for rats is 31,000 mg/kg, 30,000 mg/kg, for mice, and 34,000 mg/kg for rabbit [12].

REFERENCES

1. Howard, P.H., 1989. Handbook of Environmental Fate and Exposure Data For Organic Chemicals. Vol. I: Large Production and Priority Pollutants. Lewis Publishers, Inc. Chelsea, MI. 574 pp.

2. Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company, New York.

3. Howard, P.H.; Boethling, R.S.; Jarvis, W.F.; Meylan, W.M.; and Michalenko, E.M.; 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.

4. ATSDR, 1991. Toxicological Profile for Di(2-Ethylhexyl)Phthalate. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.

5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

6. Autian, J., 1973. Toxicity and health threats of phthalate esters - review of literature. Environmental Health Perspectives. Vol. 4:3-26.

7. Arthur D. Little, Inc., 1985. The Installation Restoration Program Toxicology Guide. Volume I. Cambridge, MA.

8. Johnson, W.W. and M.T. Finley, 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior, Fish and Wildlife Service. Resource Publication 137.

9. Micromedex, Inc. 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.

10. USEPA. 1991. Water Related Environmental Fate of 129 Priority Pollutants. Vol. II. Office of Water and Waste Management, Washington, D.C. EPA-440/4-79-029.

11. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.

12. Sax, N.I., 1984. Dangerous Properties of Industrial Materials. 6th ed. Van Nostrand Reinhold, New York. p. 641.

2-BUTANONE

CAS NUMBER

78-93-3

COMMON SYNONYMS

Methyl ethyl ketone, MEK.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 239.000 mg/L [1]
Vapor Pressure: 90.6 mm Hg at 25°C [1]
Henry's Law Constant: 1.05×10^{-5} atm-m^3/mole [1]
Specific Gravity: 0.805 at 20/4°C [2]
Organic Carbon Partition Coefficient: 34 [1]

FATE DATA: HALF-LIVES

Soil: 1 to 7 days [3]
Air: 2.7 to 26.7 days [3]
Surface Water: 1 to 7 days [3]
Groundwater: 2 to 14 days [3]

NATURAL SOURCES

Volcanoes, forest fires, products of biological degradation, food [1].

ARTIFICIAL SOURCES

Chemical industry, coatings industry, manufacturing, combustion of gasoline, cigarette smoke. Present in smog as the result of natural photooxidation of olefinic hydrocarbons from automobiles and other sources [1].

FATE AND TRANSPORT

Some of the MEK released to soil will partially evaporate into the atmosphere, while some may leach to groundwater, where it may slowly biodegrade. It does not strongly adsorb to soils and sediments. If released to surface water, it will be lost slowly to evaporation or slowly biodegraded. It does not significantly bioconcentrate in aquatic organisms. It photodegrades in the atmosphere at a moderate rate, but may be removed by rainfall first [1].

HUMAN TOXICITY

General. MEK is considered to be of low toxicity. Moderate air concentrations of MEK may cause mild irritation of the nose, throat, eyes, and skin in humans. Serious health effects in animals have been observed only at very high concentrations [4]. The USEPA has placed MEK in weight-of-evidence Group D; that is, it is not classifiable as to human carcinogenicity [5].

Oral Exposure. The chronic RfD of 0.6 mg/kg/day is based on a NOAEL of 1771 mg/kg/day for decreased fetal birth weight in a multigeneration/developmental study in rats [5]. MEK is rapidly absorbed following oral exposure. The oral LD_{50} reported for rats was 2,737 mg/kg. Exposure of rats to 1,080 mg/kg caused minor kidney damage. A clinical report of human ingestion of an unknown quantity of MEK indicated some cardiopulmonary distress, but resulted in full recovery within less than a week [4].

Inhalation Exposure. The chronic RfC of 1 mg/m^3 is based on a NOAEL of 2978 mg/m^3 for decreased fetal birth weight in a developmental study in mice [5]. MEK is well absorbed during inhalation exposure. Uptake by humans ranged from 41% to 53% of the inspired quantity. The 4-hour LC_{50} in rats was 11,700 ppm. No rats died within 14 days of exposure to 92,239 ppm for 0.5 hours. Guinea pigs exposed to 10,000 ppm became unconscious within 5 hours. No information was found regarding human deaths following exposure to MEK. Humans exposed to 100 ppm MEK complained of slight nose and throat irritation which became objectionable at 300 ppm. Exposure of pregnant rats to 3,000 ppm during gestation resulted in only a slight increase in the number of malformed fetuses [4].

Dermal Exposure. No information was located regarding the rate or extent of absorption following dermal exposure in humans or animals. The dermal LD_{50} for MEK in rabbits was reported to be 10 mL/kg. Application of 0.1 ml MEK to the forearms of humans once daily for 18 days produced no adverse effects. Application of MEK to rabbits and guinea pigs caused minimal skin irritation, erythema, and/or increase in skin-fold thickness. MEK was found to be moderately irritating to the eyes of rabbits [4].

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. II: Solvents. Lewis Publishers, Inc. Chelsea, Michigan. 546 pp.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.

3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.

4. ATSDR, 1990. Toxicological Profile for 2-Butanone. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.

5. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.

BUTYLBENZYLPHTHALATE

CAS NUMBER

85-68-7

COMMON SYNONYMS

Benzyl butyl phthalate

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 2.69 mg/L at 25°C [1]
Vapor Pressure: 8.60 x 10^{-6} mm Hg at 20°C [1]
Henry's Law Constant: 1.3 x 10^{-6} atm-m^3/mole [1]
Specific Gravity: 1.1 at 25/25°C [2]
Organic Carbon Partition Coefficient: 17,000 [1]

FATE DATA: HALF-LIVES

Soil: 1 - 7 days [3]
Air: 6 hours - 2.5 days [3]
Surface Water: 1 - 7 days [3]
Groundwater: 2 days - 6 months [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Almost always used as a plasticizer. Half of its production is used in PVC flooring products; and the other fifty-percent is used in adhesives in the packaging industry. [4]

FATE AND TRANSPORT

BBP may be released into the environment from its production, distribution, and polyvinyl chloride blending operations. BBP is most commonly found in the soil and water, and not often in the atmosphere. BBP has a high K_{oc} value, and will tend to adsorb to soil, and therefore, is not likely to leach into the groundwater. In water, BBP will adsorb to sediments and biota, and will not volatilize to any great extent, except under windy weather conditions or in shallow water bodies. Biodegradation is primarily the loss mechanism, and occurs under anaerobic conditions [1].

HUMAN TOXICITY

General. The major targets of BBP toxicity are the liver, kidneys and testes [4]. BBP is considered to be nonmutagenic. BBP has been placed in weight-of-evidence cancer Group C, indicating that it is a possible human carcinogen [5].

Oral Exposure. A chronic oral RfD of 0.2 mg/kg/day is based on a NOAEL of 159 mg/kg/day for increased liver-to-body weight and liver-to-brain weight ratios in a subchronic study in rats [5]. BBP is absorbed following oral exposure but the extent of absorption is not known. Acute oral LD_{50} values of 2330 and 4170 mg/kg were reported for rats and mice, respectively [4]. An LD_{50} of 20,400 mg/kg in rats was found for undiluted material [4]. Ingested BBP has not been reported to be fatal to humans and information is not available regarding the effects of oral exposure of humans to BBP. In animals, short-term administration of high levels of BBP (25,000 mg/kg/day) resulted in effects on the testes (degeneration) and long-term administration to lower levels (2,000 mg/kg) resulted in effects on the liver (increased liver weight, focal necrosis) and kidneys (increased kidney weight) [4]. It is not known whether ingested BBP will effect human development. No evidence of fetotoxicity or teratogenicity was reported in rabbits [4]. There is no evidence that ingested BBP causes cancer in humans, but studies in animals suggest that BBP may cause leukemia in female rats [4]. An oral Slope Factor for cancer is not available for BBP [5].

Inhalation Exposure. A chronic inhalation RfC is not available for BBP [5]. BBP is absorbed following inhalation exposure, but the extent of absorption is not known. An acute inhalation LC_{50} value of 13,100 mg/m^3 was reported for mammals (exact species not specified) [6]. Inhaled BBP has not been reported to be fatal to humans and information is not available regarding the effects of inhalation exposure of humans to BBP. In animals, short-term exposure to 1936 mg/m^3 resulted in decreased body weight and atrophy of the spleen and testes, while long-term exposure to 200 mg/m^3 resulted in decreased kidney weight (decrease liver weight was noted at a higher concentration) [4]. There is no evidence that inhaled BBP causes effects on development or cancer in humans or animals. An inhalation Unit Risk for cancer is not available for BBP [5].

Dermal Exposure. An acute dermal LD_{50} value of greater than 10,000 mg/kg is reported for rabbits [4]. In humans, a repeat insult patch test indicated that BBP is not a primary or cumulative skin irritant or sensitizing agent [4].

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. I: Large Production and Priority Pollutants. Lewis Publishers, Inc. Chelsea, Michigan. 574 pp.
2. Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company, New York.

3. Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., Michalenko, E.M., 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.

4. Arthur D. Little, Inc., 1987. The Installation Restoration Program Toxicology Guide. Volume 3. Cambridge, MA. June 1987.

5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

6. Sax, N.I., 1984. Dangerous Properties of Indistrial Materials. Sixth Edition. Van Nostrand Reinhold Company. New York.

CADMIUM

CAS NUMBER

7440-43-9

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Neglibible [2]
Henry's Law Constant: ND
Specific Gravity: 8.65 at 25/4°C [1]
Organic Carbon Partition Coefficient: ND

BACKGROUND CONCENTRATIONS

Pure cadmium is a silver-white, blue-tinged, lustrous metal with a distorted hexagonal close-packed structure; cadmium is easily cut with a knife. Cadmium can be found in zinc ores, as greenockite (CdS), and as otavite ($CdCO_3$). The estimated occurrence of cadmium in the earth's crust is from 0.1 to 0.2 ppm [1]. No data on cadmium was gathered as part of the 1984 Department of the Interior survey of conterminous United States soils [3].

FATE AND TRANSPORT

Elemental cadmium is insoluble in water [1], while cadmium compounds show varying degrees of solubility depending on the nature of the compounds and the aquatic environment [2]. Cadmium in the environment may be found as cadmium salts, hydrated cations, or organic/inorganic cadmium complexes. As hydrated cations or complexes, cadmium may be considered fairly mobile in water (relative to other heavy metals). Cadmium in soils may leach into water, especially under acidic conditions. It does not volatilize from either waters or soils, but does exhibit a tendency to adsorb strongly to clays, muds, and humic/organic materials in soils and waters. Complexation and sorbing with organic materials are the most important factors in aquatic fate and transport. The evidence indicates that cadmium bioconcentrates in all levels of the food chain. Cadmium accumulation has been reported in many animal and plant species. Reported

BCFs range from 113 to 18,000 for invertebrates, and from 3 to 2,213 for fish. The pH and humus content of the water affect bioconcentration [2].

HUMAN TOXICITY

General. Breathing air with very high levels of cadmium severely damages the lungs and can cause death. High cadmium levels in the diet severely irritate the digestive tract, while lower levels consumed over a long period of time may cause kidney damage [2]. The USEPA has placed cadmium in weight-of-evidence Group B1, indicating that it is a probable human carcinogen [4].

Oral Exposure. A chronic oral RfD of 0.0005 mg/kg/day for water is based on a NOAEL of 0.005 mg/kg/day for proteinuria following chronic exposures in humans. A chronic oral RfD of 0.001 mg/kg/day for food is based on a NOAEL of 0.01 mg/kg/day for proteinuria following chronic exposures in humans [4]. It is estimated that humans absorb about 5 percent of ingested cadmium [2]. In rats and mice the acute oral LD_{50} values range from about 100 to 300 mg/kg. Two human deaths due to intentional ingestion of cadmium resulted from doses of 25 and 1,500 mg/kg [4]. Symptoms of acute toxic reaction to ingestion may include gastroenteritis, vomiting, diarrhea, abdominal pain, increased salivation, choking, anemia, hypotension, respiratory arrest, pulmonary edema, renal dysfunction, and death. Chronic oral overexposure symptoms may include renal dysfunction and/or failure, as well as anemia [1,2,5]. Cadmium has been implicated as a fetotoxin by the oral route in animal studies [2].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for cadmium [4,6]. It is estimated that humans rapidly absorb about 25 percent of inhaled cadmium. The 15-minute LC_{50} for rats exposed to cadmium oxide fumes is approximately 33 mg/m^3. It has been estimated that exposure to 1 mg/m^3 for 8 hours might be sufficient to cause death in humans [2]. Symptoms associated with acute cadmium poisoning via inhalation may include fever, headache, dyspnea, pleuritic chest pain, conjuctivitis, rhinitis, sore throat, cough, pulmonary edema, extreme restlessness, respiratory failure, and death. Chronic inhalation overexposure symptoms may include renal dysfunction and/or failure, dyspnea, emphysema, bronchitis, and anemia [1,2,5]. Cadmium has been implicated as a developmental toxin by the inhalation route in animal studies [2], An inhalation unit risk of 0.0018 (ug/m^3)$^{-1}$ is based on excess lung cancers observed in humans [4].

Dermal Exposure. Cadmium is poorly absorbed through the skin [2]. No other useful information regarding dermal exposure to cadmium was located.

ECOLOGICAL TOXICITY

General. Cadmium is considered nonessential for plants and animals. It is relatively mobile in the environment compared to most other heavy metals. Cadmium occurs naturally in close association with zinc, usually in concentrations directly related to zinc levels [7]. Its cumulative nature in organisms and its high toxicity makes it an extremely dangerous poison for most animals. Cadmium is accumulated through the food chain in sufficient quantities to be harmful to higher trophic levels. However, no evidence was found of biomagnification of this element through trophic levels [8].

Vegetation. The soil chemistry of bioavailable cadmium is controlled by pH. Brooks [9] reported that the general toxicity of cadmium to plants was moderate. Cadmium is usually more available in acidic, sandy soils than in neutral or alkaline soils with large amounts of clay and organic matter [7]. Absorption is strongly pH-dependent, increasing as conditions become more alkaline. It has been suggested that there is a 100-fold increase in cadmium absorption for each unit increase in pH [10]. Plants tissues normally contain <0.5 ppm cadmium, but many species may accumulate much higher concentrations (up to several hundred ppm) when they grow in soil with elevated cadmium concentrations. Cadmium levels in plant tissues may subsequently affect the balance of essential elements in the plant [7]. It has been noted that 3 mg/kg of cadmium in the tissues of plants depressed growth [11]. Tall fescue (*Festuca arundinacea*) had a reduced yield of 50 percent with a soil concentration of 320 mg/kg [10].

Aquatic Life. In aquatic systems, water hardness affects the biological toxicity of cadmium. The uptake of cadmium is faster in hard water than in soft water, but the total concentration of cadmium is greater in soft water [12]. Cadmium uptakes also increase with increasing water temperature and decreasing salinity [8]. The environmental mobility of cadmium is influenced by the pH levels in the water. Cadmium is less mobile in alkaline waters than in acid waters because it becomes chemically bound in alkaline waters [13]. Cadmium can be quite toxic to aquatic organisms, even in concentrations of less than 1 ppm [10]. Fish are quite susceptible to acute toxicity, with reported 4-day LC_{50} values ranging from 0.002 to 2.9 mg/L [8]. Cadmium has been reported to accumulate in the tissues of aquatic organisms at concentrations hundreds to thousands of times higher than in the water [12]. The federal chronic freshwater quality criterion for cadmium is 3.37 μg/L based on water hardness of 400 mg/L $CaCo_3$ [14].

Wildlife. Cadmium has been shown to have a toxic effect on a variety of mammals and birds. Mammals have no effective mechanism for the elimination of ingested cadmium; therefore, the cadmium tends to accumulate in the liver and kidneys. Its relative toxicity to mammals has been rated from moderate to high [15]. Toxic effects include decreased growth rates, anemia, infertility, fetus abnormalities, abortion, kidney disease, intestinal disease, and hypertension [11]. The known effects for mallards are all sublethal.

primarily affecting the kidneys, testes, and egg production [8]. In mallards chronically dosed with cadmium contaminated food, significant effects on energy metabolism were found at 450 mg/kg, but not at 150 mg/kg [11]. In general, cadmium levels in excess of 20 ppm may reduce reproductive output of nesting waterfowl. More direct effects on individual mallards may occur as cadmium levels approach 200 ppm [8].

REFERENCES

1. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
2. ATSDR, 1991. Toxicological Profile for Cadmium. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
3. USGS, 1984. Elemental Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United Stages Geological Survey Professional Paper 1270. U.S. Department of the Interior. United States Government Printing Office, Washington, D.C. 105 pp.
4. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
5. Ellenhorn, M.J., and Bareclous, D.G., 1988. Medical Toxicology - - Diagnosis and Treatment of Human Poisoning. Elsevier Science Publishing Company, Inc. New York, NY. 1512 pp.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
7. U.S. Fish and Wildlife Service, 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitats. FWS/OBS-78/29.
8. Snyder, B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
9. Brooks, R.R., 1972. Geobotany and Biogeochemistry in Mineral Exploration. New York, Harper and Row. 290 p.
10. USEPA, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
11. CH2M Hill, Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver, Colorado.
12. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I. Office of Water and Waste Management, Washington, D.C. EPA-440/4-79-029.
13. Golder Associates, Inc., 1991. Final Remedial Investigations for Mosley Road Sanitary Landfill. Denver, Colorado.
14. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.

15. Gough, L.P., H.T. Shacklette, and A.A. Case. 1979. Element Concentrations Toxic to Plants, Animals, and Man. U.S. Geological Survey Bulletin. No. 1466. Washington, D.C.

CARBAZOLE

CAS NUMBER

86-74-8

COMMON SYNONYMS

Dibenzopyrole

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: insignificant at 25°C [2]
Henry's Law Constant: ND
Specific Gravity: 1.10 at 18/4°C [2]
Organic Carbon Partition Coefficient: 12,882 [3]

FATE DATA: HALF-LIVES

Soil: ND
Air: ND
Surface Water: ND
Groundwater: ND

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Important as a dye intermediate. Used in the formulation of photographic plates sensitive to ultraviolet light. Lignin, carbohydrate, and formaldehyde reagent. [1]

FATE AND TRANSPORT

Given its high K_{oc} value and insolubility in water, carbazole will be tightly bound to soil and is unlikely to migrate to groundwater. Carbazole is not likely to volatilize from soil or water. Information regarding biodegradation of carbazole in the environment and bioconcentration of carbazole in aquatic organisms was not located.

HUMAN TOXICITY

Very little information is known regarding the toxicity of carbazole to humans and animals. An acute oral LD_{50} value of > 5000 mg/kg is reported for rats [1]. The lowest lethal reported dose in rats is 500 mg/kg [4]. Chronic oral RfD and inhalation RfC values are not available [5,6]. Carbazole has been placed in USEPA weight-of-evidence Group B2, indicating that it is a probable human carcinogen [6]. An oral slope factor of 0.02 $(mg/kg\text{-}day)^{-1}$ is based on an increased incidence of liver tumors in mice [6]. An inhalation unit risk for cancer is not available [5,6].

REFERENCES

1. Merck, 1989. The Merck Index. Eleventh Edition. Merck and Company, Inc. Rahway, New Jersey.
2. Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company, Inc. New York, New York. 1310 pp.
3. National Institute for Occupational Safety and Health. 1991. Registry of Toxic Effects of Chemical Substances (RTECS). Volume I - III. United States Department of Health and Human Services. Cincinnati, OH.
4. Sax, N.I., 1984. Dangerous Properties of Indistrial Materials. Sixth Edition. Van Nostrand Reinhold Company. New York.
5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
6. USEPA, 1994. Health Effects Assessment Summary Table (HEAST). Office of Emergency and Remedial Response. March, 1994.

CHLORDANE

CAS NUMBER

57-74-9 for nonstereospecific chlordane; 5103-71-9 for cis- or alpha-chlordane; 5103-74-2 for trans- or gamma-chlordane

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Pesticide (organic).

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.056 - 0.1 mg/L at 25°C [1]
Vapor Pressure: 3.0×10^{-6} to 4.6×10^{-4} mm Hg at 25°C [1]
Henry's Law Constant: 4.85×10^{-5} to 1.3×10^{-3} atm-m^3/mole [1]
Specific Gravity: 1.59 - 1.63 at 25°C [2]
Organic Carbon Partition Coefficient: 15,500 - 24,600 [1]

FATE DATA: HALF-LIVES

Soil: 283 days - 3.8 years [3]
Air: 5.2 hours - 2.2 days [3]
Surface Water: 283 days - 3.8 years [3]
Groundwater: 1.6 - 7.6 years [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Chlordane was used in the past as an insecticide [1].

FATE AND TRANSPORT

Chlordane may persist for long periods of time if released to soil. Given the high K_{oc} value, chlordane is expected to be generally immobile or only slightly mobile in soil; however, movement into groundwater may occur. Chlordane may volatilize from surface soils on which it has been sprayed, particularly if the soil is moist. Incorporation into shallow soils, however, will greatly reduce volatilization. If released to water, chlordane is not expected to undergo significant hydrolysis, oxidation or photolysis. Adsorption to sediment will inhibit volatilization. Chlordane is biotransformed very slowly and has a high potential to bioconcentrate (BCF for fish: 8,320-11,500). In the air, chlordane will be predominantly in the vapor phase. Long range transport of chlordane through the atmosphere is known to occur [1].

HUMAN TOXICITY

General. The major target of chlordane toxicity is the central nervous system [4,5]. Chlordane is generally considered nonmutagenic. The USEPA has placed chlordane in weight-of-evidence cancer Group B2, indicating that it is a probable human carcinogen [6].

Oral Exposure. A chronic oral RfD of 0.00006 mg/kg/day is based on a NOEL of 0.055 mg/kg/day for regional liver hypertrophy in a chronic study in rats [6]. Chlordane is readily absorbed following oral exposure. Acute oral LD_{50} values of 200 to 335 mg/kg in rats and 1720 mg/kg in hamsters have been reported [4,5]. The fatal oral dose for adults is estimated to be between 86 and 860 mg/kg, with the onset of symptoms within 45 minutes to several hours after ingestion [4,5]. Acute symptoms include vomiting, diarrhea, seizures, coma and respiratory failure [5]. Convulsive symptoms have occurred at doses of 32 mg/kg [5]. Chronic animal studies suggest chlordane causes liver and kidney damage, but these findings have not been observed with long-term human exposure [4,5]. Information regarding the effects of ingested chlordane on human reproduction and development are not available, but animal studies indicate that exposure to high doses for several generations results in decreased fertility and viability of the offspring [5]. There is no evidence that ingestion of chlordane causes cancer in humans, but studies in animals suggest that oral exposure to chlordane may result in liver cancer [4]. An oral slope factor of 1.3 $(mg/kg/day)^{-1}$ is based on the increase in the incidence of liver cancer in mice [6].

Inhalation Exposure. An inhalation RfC for chlordane is currently under review by the USEPA [6]. Chlordane is readily absorbed following inhalation exposure. An acute inhalation LC_{50} value of 100 mg/m^3 is reported for a 4-hour exposure in cats [5]. Inhaled chlordane has not been reported to be fatal to humans. Symptoms associated with accidental inhalation exposure to chlordane include headache, dizziness, vision problems, incoordination, excitability, weakness, muscle twitching, convulsions, gastrointestinal effects, and jaundice [4,5]. The exposure concentration necessary to elicit these effects is not known. Several epidemiologic studies involving occupational exposure to chlordane do not provide any evidence of increased cancer mortality, although anecdotal reports suggest a relationship between exposure to chlordane and a noncancer blood disease, acute leukemia, and development of malignant tumors in children. An inhalation unit risk of 0.00037 $(\mu g/m^3)^{-1}$ was extrapolated from the oral slope factor [6].

Dermal Exposure. Acute dermal LD_{50} values of 690 to 840 mg/kg in rats and 780 to 1150 mg/kg in rabbits have been reported [4]. Dermal exposure to chlordane has been reported to be fatal to humans, but the fatal dose is not known. Chlordane is rapidly absorbed through the skin [5]. Effects on the central nervous system similar to those reported following other routes of exposure have been reported following dermal exposure to chlordane [4,5].

ECOLOGICAL TOXICITY

General. Chlordane was widely used as an insecticide until 1975, when the USEPA severely limited its use in the United States [7]. As would be expected from this class of compounds, it has a high environmental toxicity to invertebrates and is also quite toxic to fish, birds, and mammals. It also shows strong tendencies for bioaccumulation, with bioconcentration factors on the order of 10^3 to 10^5 for both plants and animals. Its persistence in the environment, its ability to bioconcentrate in almost all classes of biota, and its ability to biomagnify through the food chain make chlordane a greater ecological risk than most other organochlorines.

Vegetation. Sax [8] summarized several articles that studied the effects of chlordane on plants. According to this source, Probst and Everly [9] found no effect to mature soybeans or to harvest yield from the application of chlordane at a rate of 2.1 pounds per acre (which translates to a concentration in near-surface soils of approximately 1 ppm). Juska [10] found decreased germination of *Poa annua* (annual bluegrass) seeds in soils treated with chlordane at a rate of 260 pounds per acre (about 130 ppm in near-surface soils) and in *Poa pratensis* (Kentucky bluegrass) seeds in soils with chlordane applications of 87 pounds per acre (about 40 ppm in near-surface soils). Sources reviewed by Eisler [11] found that low (0.1 to 100 μg/L) concentrations of chlordane stimulated the growth of simple freshwater plants like blue-green and green algae, but that growth was inhibited by higher concentrations [12,13]. These data indicate that chlordane has relatively low toxicities to plants compared to its effects on animals.

Chlordane has been shown to bioconcentrate in both terrestrial and aquatic plants. Studies summarized in Eisler [11] showed dry-weight concentrations in corn stalks and kernels of 1,260 μg/kg and 480 μg/kg, respectively. Dry-weight concentrations in sorghum were 420 μg/kg. Bioconcentration factors of 10^4 were reported in green algae [14]. Although in-tissue concentrations of chlordane may not be toxic to the plants, they could be important as sources of chlordane in higher trophic levels.

Aquatic Life. The federal aquatic life criterion for chlordane for the chronic protection of freshwater aquatic life is 0.0043 μg/L [15]. The corresponding criterion from Ohio for chlordane is 0.0048 μg/L [16].

These standards derive from the high toxicity of chlordane to aquatic invertebrates and fish. For example, studies show that 96-hour LC_{50}s (acute toxicities) for invertebrates are usually between 4 μg/L and 40 μg/L [7,14,17]. Most 96-hour LC_{50}s for fish are in a similar range, falling between 10 μg/L and 60 μg/L [7,14,17]. Eisler [11] reports that water concentrations between 0.2 μg/L and 3 μg/L were harmful (chronic toxicity) to various species of fish and aquatic invertebrates. Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [7].

A major concern to aquatic life is the bioconcentration of chlordane. Studies show bioconcentration factors for invertebrates and fish generally ranging from 10^3 to 10^5 [7,18,8,14]. The USEPA [18] cites data showing half lives for the elimination of chlordane in invertebrates and fish in the range of 2 to 3 days. However, most other sources indicate biological half lives in aquatic life of 4.4 weeks to 20 weeks [11,14,17]. One study reported in Eisler [11] estimated that 99 percent of alpha-chlordane remained in goldfish tissues after 25 days. Generally, alpha-chlordane persisted longer in tissue than did gamma-chlordane [11,17]. Bioaccumulation of chlordane is important both because the chemical can build up to toxic concentrations in the animal's tissues and because it serves as a source of toxic levels of chlordane to higher trophic levels.

Although the use of chlordane has been highly restricted since 1975, substantial concentrations of chlordane were detected in fish samples collected a decade later. Data presented in Eisler [11] show that numerous samples of whole fish, fish muscle, or fish eggs collected in the United States in the mid-1980's had chlordane concentrations in excess of 1,000 μg/kg wet weight, and some values were greater than 5,000 μg/kg wet weight. These values exceeded both the guideline for protection of predatory fish of 0.1 mg/kg fresh weight and the Food and Drug Administration's action level of 0.3 mg chlordane per kg of fresh weight for protection of human health [11].

<u>Wildlife.</u> Toxicity of chlordane to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents and rabbits. In warm-blooded animals, chlordane is transformed to oxychlordane and/or heptachlor epoxide, both of which are more toxic and persistent than chlordane [11]. (See the discussion on heptachlor epoxide in the heptachlor profile). Chlordane and its metabolites accumulate chiefly in the adipose tissue but are also found in the liver, kidney, brain, and muscle [11,14]. The half-life of chlordane in the mammalian body is reported as ranging from 1 day to 88 days [11,14]. The half-life for oxychlordane in mammals is about 92 days [11].

Birds are also susceptible to chlordane poisoning. Studies summarized in Micromedex Inc. [14] showed that mallards, ring-necked pheasants, bobwhite quail, and Japanese quail had 5-day LD_{50}'s for ingestion of chlordane ranging from 330 ppm to 850 ppm.

However, Eisler [11] reports that sensitive bird species had reduced survival on diets containing chlordane at 1.5 mg/kg.

Some chlordane isomers persist in avian tissues for lengthy periods. For example, the biological half-lives of alpha-chlordane, cis-nonachlor (a chlordane metabolite) and oxychlordane in northern gannets were estimated to be 11.2, 19.4, and 35.4 years, respectively [11]. As recently as 1986, maximum brain tissue concentrations of these compounds in many species of debilitated birds collected in New York were above 2,000 μg/kg fresh weight, with some values above 8,000 μg/kg. Affected species included hawks, herons, jays, owls, robins, grackles, bluebirds, and starlings [11]. Lethal exposures of birds to chlordane in the environment occurred at least a decade after the use of this chemical was restricted, with chlordane implicated as the principal toxicant in 30 pesticide poisonings of hawks, owls, herons, and other birds in New York between 1982 and 1986 [11]. Secondary poisonings of raptors after consumption of prey that had accumulated large quantities of chlordane also have been documented [11].

REFERENCES

1. Howard, P.H., 1991. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. III: Pesticides. Lewis Publishers, Inc. Chelsea, Michigan. 684 pp.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. ATSDR, 1989. Toxicological Profile for Chlordane. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
5. Arthur D. Little, Inc., 1987. The Installation Restoration Program Toxicology Guide. Volume 3. Cambridge, MA. June 1987.
6. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
7. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials, Washington, D.C.
8. Sax, N.I. (ed.), 1987. Chlordane. Dangerous Properties of Industrial Materials Report. Van Nostrand Reinhold, New York. Vol.7 (6): 46-55.
9. Probst, A.H., and R.T. Everly, 1957. Effect of foliage insecticides on growth, yield and chemical composition of soybeans. Agron. J. 49:577-581.
10. Juska, F. V., 1961. Pre-emergence herbicides for crabgrass control and their effects on germination of turfgrass species. Weeds 9:137-144.

11. Eisler. R.. 1990. Chlordane Hazards to Fish. Wildlife. and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews. Report 21. Biological Report 85 (1.21). U.S. Department of the Interior, Fish and Wildlife Service. Washington, D.C.

12. Glooschenko, V., and J. N. A. Lott, 1977. The effects of chlordane on the green alga Scenedesmus quadricauda and Chlamydomonas sp. Can. J. Bot. 55:2866-2872.

13. Glooschenko, V., M. Holdrinet, J. N. A. Lott, and R. Frank, 1979. Bioconcentration of chlordane by the green alga Scenedesmus quadricauda. Bull. Environ. Contam. Toxicol 21:515-520.

14. Micromedex Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.

15. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.

16. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code. Title 3745-Chapter 1. Ohio Environmental Protection Agency.

17. Johnson, W.W.. and M.T. Finley, 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior. Fish and Wildlife Service. Resource Publication 137. Washington. D.C.

18. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I: Introduction and Technical Background. Metals and Inorganics. Pesticides and PCB's. Office of Planning and Standards, Office of Water and Waste Management. Washington D.C. EPA-440/4-79-029a.

CHLOROFORM

CAS NUMBER

67-66-3

COMMON SYNONYMS

Trichloromethane

ANALYTICAL CLASSIFICATION

Volatile (organic).

PHYSICAL AND CHEMICAL DATA

Water Solubility: 7.950 mg/L [1]
Vapor Pressure: 246 mm Hg at 25°C [1]
Henry's Law Constant: 4.35×10^{-3} atm-m^3/mole [1]
Specific Gravity: 1.484 at 20/20°C [2]
Organic Carbon Partition Coefficient: < 34 [1]

FATE DATA: HALF-LIVES

Soil: 1 to 6 months [3]
Air: 26 to 260 days [3]
Surface Water: 1 to 6 months [3]
Groundwater: 2 months to 5 years [3]

NATURAL SOURCES

Plants [1].

ARTIFICIAL SOURCES

Chemical industry, chlorination of drinking water, municipal sewage, power plants, auto exhaust, dry cleaning industry, fumigation, manufacturing [1].

FATE AND TRANSPORT

The majority of chloroform released to the environment ends up in the atmosphere, where it may be transported long distances. It is not adsorbed significantly on soils or sediment. Chloroform in soils will leach to groundwater, where it may remain for long periods of time or until discharged. Since it is substantially denser than water, when it occurs as a separate phase it tends to sink to the bottom of the aquifer. Releases to surface soils and water will be dissipated primarily by evaporation. It is subject to significant biodegradation. It is not expected to bioconcentrate in aquatic organisms [1].

HUMAN TOXICITY

General. Chloroform exerts adverse effects on the central nervous system, liver, and kidneys. It was used as a surgical anesthetic for many years before its harmful effects on the liver and kidney were recognized. High doses of chloroform have also been found to cause liver and kidney cancer in experimental animals [4]. The USEPA has placed chloroform in weight-of-evidence Group B2, indicating that it is a probable human carcinogen [5].

Oral Exposure. A chronic oral RfD of 0.01 mg/kg/day is based on a LOAEL of 12.9 mg/kg/day determined for fatty cyst formation following chronic administration to dogs [5]. Chloroform is readily absorbed following oral exposure, with up to 100% of an administered dose being absorbed by humans. Acute oral LD_{50} values in rats range from 446 to 2,180 mg/kg. Reported fatal oral doses for humans ranged from 212 to 3,755 mg/kg. Long-term exposure by ingestion can adversely affect liver and kidney function. Toxic effects may include jaundice and burning urination. Decreased fetal weight was observed in the offspring of pregnant rats receiving 400 mg/kg/day by gavage. Gonadal atrophy was observed in both sexes of rats treated by gavage at a rate of 410 mg/kg/day [4]. An oral slope factor of 6.1×10^{-3} $(mg/kg/day)^{-1}$ is based on kidney tumors observed in rats following exposure to treated drinking water [5].

Inhalation Exposure. An inhalation RfC for chloroform is currently under review by the USEPA RfD/RfC Work Group [6]. Chloroform is readily absorbed following inhalation exposure. An LC_{50} of 9,770 ppm was reported for female rats exposed for 4 hours. Breathing air concentrations of 10,000 to 22,500 ppm for less than 30 minutes did not result in increased mortality in human surgical patients. A concentration of about 40,000 ppm for a few minutes may be sufficient to cause death in humans. Deaths resulting from the use of chloroform as a surgical anesthetic were due to acute hepatotoxicity. Short-term inhalation of high concentrations causes tiredness, dizziness, and headache. Long-term exposure by inhalation can adversely affect liver and kidney function. Toxic effects may include jaundice and burning urination. Chloroform has been shown to be fetotoxic and teratogenic in experimental animals. Adverse reproductive effects in male and female rodents have also been reported [4]. An inhalation unit risk of 2.3×10^{-5} $(mg/m^3)^{-1}$ is based on hepatocellular carcinomas observed in female mice following gavage administration [5].

Dermal Exposure. Chloroform is readily absorbed following dermal exposure. No deaths or hepatic effects were observed in rabbits when 3,980 mg/kg was applied to the belly for 24 hours. However, adverse effects to the skin and kidney in rabbits were noted following 24-hour exposure to 1,000 mg/kg [4].

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. II: Solvents. Lewis Publishers, Inc. Chelsea, Michigan. 546 pp.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. ATSDR, 1987. Toxicological Profile for Chloroform. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1987.
5. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.

CHROMIUM

CAS NUMBER

7440-47-3

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 7.2 at 28°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Chromium is a naturally-occurring element which is dispersed throughout the environment primarily as a result of anthropogenic activities [1]. The concentration of chromium in minimally disturbed soils varies tremendously. A collection of 1,319 soil samples from across the conterminous U.S. determined that 87 percent were less than or equal to 70 ppm, with a geometric mean of 37 ppm, but with a maximum value as high as 700 ppm [3].

FATE AND TRANSPORT

Two of the major forms of chromium are trivalent or chromium (III), and hexavalent or chromium (VI). Chromium is released into the atmosphere mainly by the combustion of coal and oil. The most toxic form is hexavalent chromium, which is due mainly to chemical manufacture, primary metal production, chrome plating, and cooling towers. Chromium is removed from the atmosphere by fallout and precipitation, but may be transported long distances before removal. The residence time of atmospheric chromium is expected to be less than 10 days. There are no known chromium compounds that can volatilize from water. Most of the trivalent form is expected to precipitate in sediments. Hexavalent chromium will be present predominantly in the soluble form. Hexavalent chromium will eventually be reduced to the trivalent form by the organic materials present in surface water. The residence time of chromium in lake water is estimated to be in the range of 4.6 to 18 years. Bioconcentration should be minimal [1].

Chromium in soil may become airborne due to fugitive dust emissions, while runoff and leaching may transport it to surface water and groundwater. Flooding of soils and the subsequent anaerobic decomposition of plant material may increase the mobilization of chromium from soils. The half-life of chromium in soils may be several years [1].

HUMAN TOXICITY

General. There are two forms of chromium that are of concern; trivalent chromium (chromium III) and hexavalent chromium (chromium VI). In general, chromium (VI) compounds are more toxic than chromium (III) compounds [1]. Trivalent chromium (chromium III) is considered an essential nutrient which helps to maintain normal glucose, cholesterol, and fat metabolism. A daily ingestion of 0.05 to 0.20 mg/day (0.0007 to 0.003 mg/kg/day) is estimated to be safe and adequate [1]. The major targets of chromium toxicity are the respiratory system and the gastrointestinal system. Chromium is considered to be genotoxic. The USEPA [4] has placed chromium (VI) in weight-of-evidence cancer Group A, indicating that it is a human carcinogen. Chromium (III) has not been placed in a cancer class by the USEPA [4].

Oral Exposure. A chronic oral RfD value of 1 mg Cr/kg/day for chromium (III) is based on a NOEL of 1468 mg Cr/kg/day for adverse effects in a chronic feeding study in rats [4]. An oral RfD of 0.005 mg Cr/kg/day for chromium (VI) is based on a NOAEL of 2.4 mg Cr/kg/day for adverse effects in a 1-year drinking study in rats [4]. Chromium is poorly absorbed following oral exposure. Acute oral LD_{50} values in rats ranged from 13 to 2365 mg Cr/kg, depending on the chromium compound [1]. Short-term oral exposure of humans to high doses of chromium (> 4.1 mg Cr (VI)/kg/day) has resulted in stomach upsets and ulcers, convulsions, liver and kidney damage and even death [1]. Information regarding potential effects of chromium on human reproduction and development are not available. Exposure of animals to chromium (VI) (57 mg Cr (IV)/kg/day) during pregnancy has been found to result in developmental effects on the fetus [1]. Treatment of male mice with chromium (III) and (VI) (> 3.5 mg Cr/kg/day) has caused effects on spermatogenesis [1]. There is no evidence that oral exposure to chromium (III) or (VI) causes cancer in humans or animals, therefore, an oral Slope Factor is not available [4].

Inhalation Exposure. Inhalation RfC values for both chromium (III) and chromium (VI) are currently under review by the USEPA [4]. Following inhalation exposure, approximately 53-85% of chromium (VI) compounds and 5-30% of chromium (III) compounds are absorbed into the blood [1]. Acute (4-hour) inhalation LC_{50} values in rats ranged from 29 to 137 mg/kg, depending on chromium compound [1]. In humans, acute inhalation of chromium has not been reported to be fatal. The respiratory system is the major target of toxicity for both forms of chromium following inhalation exposure. Respiratory effects include perforations and ulcerations of the nasal septum, bronchitis, pneumonoconiosis (inflammation of the lung leading to fibrosis), decreased pulmonary function, pneumonia, rhinorrhea (runny nose), nasal itching and soreness and epistaxis (nose bleed) [1]. These effects have occured at concentrations > 0.002 mg Cr (VI)/m^3. In some chromium-sensitive people, chromium exposure may trigger an allergic response manifested by asthma or a skin rash. There is no conclusive evidence that inhaled chromium causes reproductive or developmental effects in humans or animals [1]. Long-term inhalation exposure of workers to low levels of chromium compounds (> 0.04 mg Cr/m^3) has been associated with lung cancer. The form of chromium responsible for this effect has not been established, but only hexavalent chromium has been found to cause cancer in animal studies. An inhalation Unit Risk of 0.012 (ug/m^3)$^{-1}$ for chromium (VI) is based on an increase in the incidence of lung cancer in occupationally exposed workers [4]. An inhalation Unit Risk is not available for chromium (III) [4].

Dermal Exposure. Acute dermal LD_{50} values in rabbits ranged from 30 to 553 mg Cr/kg depending on chromium compound [1]. Dermal exposure to chromium has been found to be fatal in humans, but the exact exposure dose is not known [1]. Dermal exposure of humans to chromium can cause allergic reactions as well as skin burns, blisters and ulcers [1]. Exposure of animals to chromium results in effects similar to those found in humans.

REFERENCES

1. ATSDR. 1991. Toxicological Profile for Chromium (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October, 1991.
2. Merck. 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. USGS. 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
4. USEPA. 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

COBALT

CAS NUMBER

7440-48-4

COMMON SYNONYMS

Cobalt-59; ^{59}Co; CI77320. [1]

ANALYTICAL CLASSIFICATION

Metal.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 8.9 at 20°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Cobalt is a naturally-occurring element found widely distributed throughout the earth's crust and organisms. The abundance of cobalt in the earth's crust has been estimated at 0.001 - 0.002% [2]. The concentration of cobalt in minimally disturbed soils varies tremendously [3]. A collection of 1,311 samples from across the conterminous U.S. determined that 78% were less than or equal to 10 ppm, with a geometric mean of 6.7 ppm, but with a maximum value as high as 70 ppm. Of fifteen samples collected around Ohio, 60 percent were found to contain cobalt at levels ranging from 10 to 70 ppm [3].

FATE AND TRANSPORT

Cobalt is a gray, hard (although somewhat malleable), magnetic, ductile metal which appears essential to life (playing an important role in animal nutrition), and which exists in two allotropic forms: hexagonal and cubic. The hexagonal form is the more stable, although both can exist, at normal ambient temperatures. In addition, both are stable in air and towards water at normal ambient temperatures. Cobalt is readily soluble in dilute nitric acid, and is slowly attacked by hydrochloric acid or cold sulfuric acid.

Compounds and/or complexes of cobalt are not usually volatile. Therefore, the transport of cobalt probably results from particulate matter interactions. Dry and wet deposition accounts for the majority of transport to soils and surface waters. As with most metals, soils and sediments are the final repository for cobalt. Transport of cobalt in soils depends upon adsorption/desorption reactions. Cobalt is also retained in soils/sediments by oxides (e.g., iron/manganese oxides) and crystalline materials (e.g., aluminosilicate, geothite). Available data, however, suggest little adsorption of cobalt to organic matter (e.g., humic and/or fulvic matter) in waters. Mobility/transport of cobalt in soils is accelerated with decreasing soil pH. Leaching to groundwaters occurs only minimally, and is postulated to be the result of the formation of pseudo-colloidal suspensions and their subsequent migration/leaching to groundwaters. Generally, cobalt exhibits greater mobility in soils than does lead, chromium (+2 state), zinc, and nickel, but lesser mobility than cadmium. Bioaccumulation of this material in aquatic organisms may be great (log bioaccumulation factor = 3.60), but biomagnification through the trophic levels does not appear to be significant. [1]

HUMAN TOXICITY

General. Cobalt is part of vitamin B_{12}, which is essential to maintain good health. Toxic effects occur, however, when too much cobalt is taken into the body. The major targets of cobalt toxicity are the blood, the heart, and the gastrointestinal system following oral exposure, and the lungs following inhalation exposure [1]. Cobalt is considered to be genotoxic. Cobalt has not been placed in a weight-of-evidence cancer group by the USEPA [4].

Oral Exposure. A chronic oral RfD for cobalt is currently under review by the USEPA [4]. Absorption of cobalt through the gastrointestinal tract is dependent on the type and dose of cobalt given and on the nutritional status of the person [1]. More cobalt will be absorbed by an iron-deficient person than by a normal person. Acute oral LD_{50} values in rats ranged from 91 to 190 mg/kg [1]. In humans, deaths were reported following long-term ingestion of large quantities of cobalt-contaminated beer (0.04 to 0.14 mg/kg/day). Cobalt was added to the beer to stabilize the foam, but this practice has since been discontinued. The victims died from cardiomyopathy. Cobalt stimulates the production of red blood cells and, therefore, has been given as a treatment for anemia (0.16-1.0 mg/kg/day) [1]. Gastrointestinal effects were noted both in the beer-drinkers and in the anemic patients. In animals, effects on the testes (degeneration) were found in addition to the cardiovascular and hematological effects found in humans [1]. Cobalt has not been found to cause birth defects in people, but exposure of animals to high doses has resulted in effects on the fetus [1]. Cobalt is not known to cause cancer following oral exposure, therefore, an oral slope factor has not been derived by the USEPA [4].

Inhalation Exposure. A chronic inhalation RfC is not available for cobalt [4]. The amount of inhaled cobalt that is absorbed depends on the size if the dust particles; the smaller the particle, the more likely it is to be absorbed through the lungs [1]. An acute

LC_{50} value of 165 mg/m^3 (30-minutes) was reported for rats [1]. There is no conclusive evidence that inhaled cobalt causes death in humans. The respiratory system is the target of inhaled cobalt. Short-term (6 hours) exposure of people to 0.038 mg/m^3 resulted in difficulty in breathing. More serious effects on the lungs (asthma, pneumonia, wheezing) have been found in workers exposed to 0.003 mg/m^3, while workers exposed to 0.007 mg/m^3 have also had allergic asthma and skin rashes [1]. The respiratory system is also the target of cobalt toxicity in animals. There is no information regarding potential effects of inhaled cobalt on reproduction, development, or cancer. An inhalation unit risk is not available for cobalt [4].

Dermal Exposure. There is no information regarding lethal dermal doses of cobalt in humans or animals. Dermal exposure to cobalt results in dermatitis that is the result of an allergic reaction to cobalt. Exposure levels associated with the dermatitis are not known [1].

ECOLOGICAL TOXICITY

General. Cobalt is an essential trace nutrient for animals and for some algae. Although growth and yield increases have been reported, it is considered non-essential to most higher plants [5]. Cobalt does not biomagnify in terrestrial or aquatic food chains.

Vegetation. The bioavailability of cobalt to plants is primarily regulated by soil pH with soil leaching and plant uptake enhanced by lower pH [6]. Phytotoxicity from soil containing 50 to 100 ppm occurs in plants and foliar symptoms resembling iron deficiency are apparent at these levels [6]. Plants exhibit a wide range of species-specific tolerances to cobalt. Symptoms of cobalt phytotoxicity are white, dead margins and tips of leaves, chlorosis of new leaves, and stunted growth [7]. Cobalt at concentrations of 10 to 400 $\mu g/L$ inhibited seed germination and concentrations at 100 to 400 $\mu g/L$ reduced plant growth and leaf chlorophyll contents [8]. These results were noted for laboratory or culture experiments. Naturally occurring excess of cobalt in soils is improbable because of soil bonding characteristics.

Aquatic Life. Cobalt is water soluble when in the form of chloride, nitrate, and sulfate salts. At a pH of 7, cobalt is 50 to 80 percent soluble when it is associated with ammonium, magnesium, calcium, sodium and potassium [6].

Among invertebrates, *Daphnia* were immobilized by 3.1 to 21.0 mg/L of cobalt, while concentrations of 16.0 to 32.0 mg/L were lethal to aquatic insect larvae in four to eight days [9]. The 10-day lethal concentration for fish is about 10.0 mg/L [9]. There are no USEPA or OEPA aquatic life water quality standards [10,11].

Wildlife. Cobalt is required by animals because it is the central atom in vitamin B12 [6]. Cobalt is relatively nontoxic to animals. No reports of cobalt toxicity attributed to consumption of natural forage were identified. Animal health can be affected by consumption of plants containing 100 ppm of cobalt [6]. Sheep can tolerate doses of 3 mg/kg body weight without adverse effects, and 200 mg/kg of cobalt in rats has been reported as toxic [12].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Cobalt. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.
2. Merck, 1989. The Merck Index, Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. United States Geological Survey (USGS), 1984. Elemental Concentrations in Soils and Other Surficial Material of the Conterminous United States. USGS Professional Paper 1270, U.S. Department of the Interior. United States Government Printing Office. Washington, D.C. 105 pp.
4. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
5. Gough, L.P., H.T. Shaklette, and A.A. Case, 1979. Element Concentrations Toxic to Plants, Animals, and Man. U.S. Geological Survey Bulletin. No. 1466. Washington, D.C.
6. USEPA, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
7. CH2M Hill, Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver, Colorado.
8. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.
9. Snyder, B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
10. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
11. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
12. U.S. Fish and Wildlife Service, 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitats. FWS/OBS-78/29.

COPPER

CAS NUMBER

7440-50-8

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 8.94 [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Copper is a naturally-occurring element. The concentration of copper in minimally disturbed soils varies tremendously. A collection of 1.311 soil samples from across the conterminous U.S. determined that 85 percent were less than or equal to 30 ppm. with a geometric mean of 17 ppm. but with a maximum value as high as 700 ppm [3]. Copper concentrations in Ohio farm soils were found to range from 11 to 37 ppm, with a mean value of 19 ppm [4].

FATE AND TRANSPORT

Copper is dispersed throughout the atmosphere primarily as a result of anthropogenic activities. Environmental fate processes may transform one copper compound to another; however, copper itself is not degraded. Most of the copper in the atmosphere occurs in the aerosol form, and long-distance transport may occur. Wet or dry deposition is expected to be the primary fate process in air.

Several processes determine the fate of copper in aquatic environments: formation of complexes, especially with humic substances; sorption to hydrous metal oxides, clays, and organic materials; and bioaccumulation. Organic complexes of copper are more easily adsorbed on clay and other surfaces than the free form. The aquatic fate of copper is highly dependent on factors such as pH, oxidation-reduction potential, concentration of organic matter, and the presence of other metals. In regard to the latter, it has been demonstrated that coprecipitation of copper with hydrous oxides of iron effectively scavenges copper from solution, although in most surface waters organic materials prevail over inorganic ions in complexing copper [5].

Generally, copper is considered to be among the more mobile of the heavy metals in surface environments. Seasonal fluctuations have been observed in surface water copper concentrations, with higher levels in fall and winter, and lower levels in the spring and summer. It is not expected to volatilize from water. Since copper is an essential nutrient, it is strongly accumulated by all plants and animals, but is probably not biomagnified [5].

The degree of persistence of copper in soil depends on the soil characteristics and the forms of copper present. For example, in soils of low organic content, soluble copper compounds may move into groundwater at a significant rate. On the other hand, the presence of organic complexing agents may restrict movement in soil, and copper may be immobilized in the form of various inorganic complexes. It is not expected to volatilize from soil.

HUMAN TOXICITY

General. Copper is an essential trace element; therefore, toxic effects can result if too much or too little is taken into the body. The Recommended Dietary Allowance (RDA) for copper is 2 to 3 mg/day (0.03 to 0.04 mg/kg/day) [6]. The major targets of copper toxicity are the gastrointestinal tract following oral exposure and the lungs following inhalation exposure [6]. Information regarding the genotoxicity of copper are equivocal. USEPA has placed copper in weight-of-evidence cancer Group D, indicating that it is not classifiable as to human carcinogenicity [7].

Oral Exposure. A chronic oral RfD of 1.3 mg/L (0.04 mg/kg/day) is based on a LOAEL of 5.3 mg/L for gastrointestinal irritation in humans [8]. Approximately 60% of an oral dose of copper is absorbed through the gastrointestinal tract [6]. Case studies of human suicides indicate that doses of 6 to 637 mg/kg have been fatal [6]. LD_{50} values are not available for animals. In humans, doses greater than 0.07 mg/kg have resulted in gastrointestinal effects including vomiting, diarrhea, nausea, abdominal pain and a metallic taste in the mouth [6]. Adverse effects were also noted in the liver (necrosis) and the kidneys (necrosis, tubular damage) of humans following oral exposure [6]. Chronic toxic effects due to copper are rarely seen except for individuals with Wilson's Disease. Wilson's Disease is a genetically determined condition in which the body absorbs and retains abnormally high copper concentrations [6]. It is not known whether exposure to copper will result in effects on reproduction or development in humans, but animal studies indicate that copper exposure may increase fetal mortality [6]. There is no evidence that copper causes cancer in humans or animals, therefore, an oral slope factor for cancer is not available [7].

Inhalation Exposure. A chronic inhalation RfC is not available for copper [7]. The extent of copper absorption following inhalation exposure is not known. Information regarding the fatal dose of copper following inhalation exposure was not located for humans or animals. In humans, copper is a respiratory irritant. Short-term inhalation exposure to copper dust or fumes (0.075-0.12 mg/m^3) results in a condition known as "metal fume fever". This condition is a 24-48 hour illness characterized by chills, fever, aching muscles, dryness in the mouth and throat and headache [6]. Respiratory effects have also been noted in animals [6]. Information is not available regarding potential effects on reproduction and development in humans or animals following inhalation exposure. There is no evidence that copper exposure causes cancer in human or animals, therefore, an inhalation unit risk for cancer is not available [7].

Dermal Exposure. Dermal exposure to copper may result in allergic contact dermatitis [6]. Other information regarding the toxic effects of dermal exposure to copper are not available [6].

ECOLOGICAL TOXICITY

General. Copper is an essential trace element or micronutrient for plants and animals. However, excessive amounts of the element are toxic [9]. Copper is accumulated by all plants and animals, but it has very little if any potential for biomagnification through the food chain [10].

Vegetation. Copper retention in soils and bioavailability to plants are dependent on pH. Sorption of copper increases with increasing pH [11]. Copper is held most securely at a pH range of 7.0 to 8.0 [12]. Several researchers have reported a decrease in plant copper when large amounts of organic matter are present. Copper is strongly chelated in plant roots. Phytotoxic concentration of copper ranges from about 70 to 640 ppm in the soil for most plants [13]. In vascular plants, toxic levels of copper can cause reduced growth, chlorosis, and stunted root development. Toxic copper concentrations also interfere with the uptake of iron and other heavy metals [9]. Copper salts have been used effectively to control aquatic vegetation, algae, and terrestrial plants invading sewer lines for many years.

Aquatic. The toxicity of copper to aquatic life varies with hardness (increases with decreased hardness), pH (increases with decreased pH), and temperature (increase with higher temperatures) [14]. Many studies have been published on the toxicity of copper to fish and other aquatic life forms. Relatively high concentrations of copper may be tolerated by adult fish for short periods of time. The critical effect appears to be its greater toxicity to young or juvenile fish [11]. Reproduction of fish is impaired at concentrations of 0.018 to 0.033 mg/L, growth is reduced at concentrations of 0.0025 to 0.0184 mg/L, and survival is reduced at 0.018 to 0.04 mg/L [9]. The maximum acceptable toxicant concentration for fathead minnows is 0.011 to 0.018 mg/L. as it affects embryo. larval. and early juvenile stages [14]. The 96-hour LC_{50} acute toxicity of copper sulfate in fathead minnows and bluegills was reported to be 1.4 mg/L and 10.2 mg/L, respectively, at a water hardness of 400 mg/L $CaCO_3$ and a pH of 8.2 [11]. The 96-hour LC_{50} acute toxicity of copper in fathead minnows and creek chub was 0.44 mg/L and 0.31 mg/L, respectively, with a water hardness of 200 mg/L $CaCO_3$ [11].

Concentrations of 0.015 mg/L produced sublethal effects in crayfish and a 4-day LC_{50} of 3.0 ppm [9]. The federal chronic freshwater quality criterion for copper is 38.7 μg/L based on a water hardness of 400 mg/L $CaCO_3$ [15]. The Ohio aquatic life habitat and water supply standard for copper is 42.0 μg/L based on a water hardness of 400 mg/L $CaCO_3$ [16].

Wildlife. Copper is an essential trace element for animals, with some species, such as sheep, being extremely sensitive to excessive concentrations of copper or to certain ratios of copper to molybdenum in their forage. Sheep have died after consuming plants and soils containing 15 ppm copper (dry weight) [17]. The maximum tolerable dietary level for turkey and chickens is 300 ppm [18]. However, copper toxicity in mammals and birds is of little significance because they possess barriers to copper absorption [19]. Mammals and birds are 100 to 1,000 times more resistance to toxic effects than aquatic biota.

REFERENCES

1. Sittig. M., 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Second Edition. Noyes Publications. Park Ridge, New Jersey. 950 pp.
2. Merck. 1989. The Merck Index. Eleventh Edition. Merck & Company. Inc. Rahway. NJ.
3. USGS. 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
4. Logan, T.J. and R.H. Miller, 1983. Background Levels of Heavy Metals in Ohio Farm Soils. Research Circular 275, Ohio State University, Ohio Research and Development Center, Wooster, Ohio. February 1983.
5. USEPA, 1979. Water-Related Fate of 129 Priority Pollutants. Volume I. Office of Water Planning and Standards. Washington, DC. EPA-440/4-79-029a. December 1979.
6. ATSDR, 1990. Toxicological Profile for Copper. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1990.
7. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March. 1995.

8. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.

9. Snyder, B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.

10. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Vol. I. Office of Water and Waste Management, Washington, D.C. EPA 440/4-79-029.

11. U.S. Environmental Protection Agency, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.

12. U.S. Fish and Wildlife Service, 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitats. FWS/OBS-78/29.

13. U.S. Environmental Protection Agency, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.

14. Engineering-Science, Inc., 1991. Waste Site Investigation for Alcoa Massena Operation, Comprehensive Biota Sampling Program Report. Volume XII. Liverpool, N.Y.

15. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.

16. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.

17. Hemkes, D.J. and J. Hartmans, 1973. Copper content in grass and soil under high voltage lines in industrial and rural areas, in Trace Substances in Environmental Health - VII. University of Missouri, Ann. Conf. 7th Proc. p 175-178.

18. CH2M Hill, Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill, Denver, Colorado.

19. Gough, L.P., H.T. Shacklette, and A.A. Case, 1979. Element Concentration Toxic to Plants, Animals, and Man. U.S. Geological Survey Bulletin, No. 466. Washington, D.C.

CYANIDE

CAS NUMBER

57-12-5

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic (wet chemistry).

PHYSICAL AND CHEMICAL DATA

Note: Data is for hydrogen cyanide (HCN).

Water Solubility: miscible [1]
Vapor Pressure: 264.3 mm Hg at)°C [1]
Henry's Law Constant: 5.1 x 10^{-2} atm-m^{3}/mole [1]
Specific Gravity: 0.6884 at 20°C (liquid) [1]
Organic Carbon Partition Coefficient: ND

FATE DATA: HALF-LIVES

Soil: ND
Air: ND
Surface Water: ND
Groundwater: ND

NATURAL SOURCES

Fruits, roots, and leaves of numerous plants [1].

ARTIFICIAL SOURCES

Vermicidal fumigants; insecticides; rodenticides; metal polishes; electroplating solutions; metallurgical processes [1,2].

FATE AND TRANSPORT

Cyanides may be found in the environment bound with organic and/or inorganic cations. The fate and transport of cyanide, therefore, is dependent upon the properties of the cyanide-bound material. Any discussion attempting to encompass all properties of cyanide-bound materials is beyond the scope of this assessment.

Cyanides may occur in soils as hydrogen cyanide, alkali metal salts, or immobile metallocyanide complexes. The fate of cyanides in soil will be largely dependent upon pH conditions of that soil. Volatilization of hydrogen cyanide from surface soils is expected to be a primary removal mechanism for soils having a pH of 9.2 or less. Though cyanide typically does not sorb strongly to soils (or organic matter therein), leaching to unprotected groundwaters is not expected to be significant due to the probability of cyanide fixation by trace metals found in soils, or transformation of cyanide via microbial action. However, if the initial cyanide loading proves toxic to soil-based microorganisms, leaching to groundwater may be expected. In water, cyanide occurs most commonly in the form of hydrogen cyanide. Hydrogen cyanide is removed from water primarily by volatilization. The rate of volatilization is also pH-dependent, with more rapid volatilization occurring at lower pH values [1].

Although simple metal cyanides and hydrogen cyanide are not expected to bioconcentrate in aquatic organisms, concentrations of simple metal cyanides have been detected in the tissues of fish exposed to waters containing silver and copper metal complexes. There is, as well, no evidence of biomagnification through trophic levels. Adsorption to suspended solids and sediments in waters will occur, but is expected to be a minor pathway in comparison to volatilization and biodegradation. [1]

Atmospheric concentrations of cyanide will exist almost exclusively as hydrogen cyanide, though small amounts of metal cyanides may exist associated with particulate matter. Given the relatively slow degradation rate of hydrogen cyanide in the atmosphere, this material has the potential to be transported for long distances. The most important removal mechanism for hydrogen cyanide in the atmosphere is via reaction with photochemically-produced hydroxyl radicals. Removal of hydrogen cyanide via either dry or wet deposition is expected to be a negligible mechanism. Metal cyanides (as particulates) will, however, be subject to deposition via gravitational settling and/or rainfall washout. [1]

HUMAN TOXICITY

General. Cyanide is highly toxic to humans following all routes of exposure. Cyanide acts by inhibiting enzymes that are needed to use oxygen efficiently, resulting in respiratory arrest. The major targets of cyanide toxicity are the central nervous system, the lungs and the heart [1]. Cyanide is not mutagenic and has been placed in weight-of-evidence cancer Group D, indicating that it is not classifiable as to human carcinogenicity [3].

Oral Exposure. A chronic oral RfD of 0.02 mg/kg/day is based on the NOAEL of 10.8 mg/kg/day for weight loss, thyroid effects and nervous system effects in a chronic study in rats [3]. Cyanide is readily absorbed following oral exposure. Acute oral LD_{50} values ranged from 2.7 to 11 mg/kg in rats. 2.34 to 2.70 mg/kg in rabbits and 4.3 mg/kg in mice [1,2]. In humans. an average fatal dose of 1.52 mg/kg has been calculated based on case reports of intentional or accidental poisonings. The lowest reported fatal dose in humans was 0.56 mg/kg [1]. Acute oral poisoning results in effects on the gastrointestinal system (vomiting), the heart (atrial fibrillation, shallow pulse. inaudible heart sounds), kidneys (increased protein output) and nervous system (tremors. stupor, coma). These effects have occurred at doses above 15 mg/kg [1]. Similar effects have been found in animals. Information regarding potential effects of cyanide on reproduction and development in humans are not available, but studies in animals indicate that effects on development may result following oral exposure [1]. Cyanide is not known to cause cancer in humans or animals following any route of exposure, therefore, an oral slope factor is not available [3].

Inhalation Exposure. A chronic inhalation RfC is not available for cyanide [3]. Cyanide is readily absorbed following inhalation exposure. Acute inhalation LC_{50} values vary according to duration of exposure: in rats, values ranged from 3,417 ppm (10 seconds) to 142 ppm (60 minutes), and in rabbits, values ranged from 2,200 ppm (45 seconds) to 208 ppm (35 minutes) [1]. In humans, an average fatal concentration is estimated to be 546 ppm for a 10-minute exposure. Exposure to 110 to 135 ppm for greater than an hour can be life-threatening, while exposure to 18-36 ppm for the same time period may not cause any effects [1]. Acute exposures to approximately 6 ppm and above may result in effects on the respiratory system (dyspnea, nasal irritation), cardiovascular system (chest pain, heart palpitations), gastrointestinal system (abdominal pain. nausea. vomiting), and nervous system (lightheadedness. breathlessness, numbness. headaches. and, at higher concentrations, coma). Chronic inhalation exposure of workers to comparable concentrations results in effects similar to those reported following acute exposure. Information regarding the potential effects of cyanide on reproduction and development are not available in humans or animals [1]. Cyanide is not known to cause cancer in humans or animals following any route of exposure, therefore, an inhalation unit risk is not available [3].

Dermal Exposure. The average fatal dose of cyanide in humans following dermal exposure was estimated to be 100 mg/kg [1]. Acute dermal LD_{50} values in rabbits ranged from 1.0 to 8.93 mg/kg [1]. Toxic effects observed following dermal exposure are similar to those following other routes of exposure [1].

ECOLOGICAL TOXICITY

General. Cyanide is a highly lethal, but short-lived noncumulative poison. No evidence was found of either cyanide bioaccumulation or biomagnification [4]. Hydrogen cyanide is the most common and the most toxic of the cyanides. The environmental chemistry of cyanide is complex, with cyanide gas (HCN) and ionic cyanide (CN^-) representing the toxic chemical forms.

Vegetation. Cyanide seldom remains biologically available in soils because it is either complexed by trace metals, metabolized by various microorganisms, or lost through volatilization. In plants, elevated cyanide concentrations inhibit respiration [5]. Some plant species, such as arrowgrass (*Triglochin* sp.) wind wild cherry (*Prunus*), are natural producers of cyano compounds and will have inherent high concentrations of these compounds in their tissues.

Aquatic. Cyanide in aquatic systems exists as simple hydrocyanic acid; as water-soluble alkali metal salts, such as potassium cyanide and sodium cyanide; and as metallocyanide complexes of variable stability [4]. Cyanide toxicity increases with decreasing pH and dissolved oxygen. Cyanide concentrations in the range from 50 to 100 μg/L have proven to eventually fatal to many sensitive fishes and levels above 200 μg/L probably are rapidly fatal to most fish species [6].

The 96-hour LC_{50} of cyanide for bluegill was 56.0 to 227.0 μg/L and the maximum toxicant concentration was 9.3 to 19.8 μg/L [5]. The 96-hour LC_{50} of cyanide for juvenile and adult fathead minnows was 117.0 to 157.0 μg/L and 121.0 to 129.0 μg/L, respectively [7]. During chronic exposure, cyanide inhibited spawning in bluegill at 5.0 μg/L and reduced growth rate in fathead minnows at 35.0 μg/L [5]. The federal chronic freshwater quality criterion for cyanide is 5.2 μg/L [8]. The Ohio aquatic life habitat and water supply standard for cyanide is 12.0 μg/L for warmwater and modified warmwater habitats [9].

Wildlife. Cyanide is acutely toxic to birds and mammals in very small concentrations. Cyanide biomagnification in the food chain has not been reported, possibly due to rapid detoxification of sublethal doses by most species, and death at higher doses [5]. In mallards, a single oral dose of cyanide of 0.53 mg/kg body weight produced no deaths, but an LC_{50} result was produced at 1.43 mg/kg body weight [5]). In rabbits, a single oral dose of 10.0 to 15.0 mg/kg body wight produced a 100 percent kill in 14 to 30 minutes [5].

REFERENCES

1. ATSDR, 1991. Toxicological Profile for Cyanide. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.

2. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide. Volume 4. Cambridge, MA. July 1989.

3. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

4. Snyder, B.D. and J.L. Snyder. 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
5. Eisler, R., 1991. Cyanide Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews. Report 23. Biological Report 85 (1.23). U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.
6. USEPA. 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
7. Engineering-Science, Inc., 1991. Waste Site Investigation for Alcoa Massena Operation. Comprehensive Biota Sampling Program Report. Volume XII. Liverpool, NY.
8. USEPA. 1991. Water Quality Criteria Summary. Washington, D.C.
9. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code-Title 3734-Chapter 1. Ohio Environmental Protection Agency.

4,4'-DDD

CAS NUMBER

72-54-8

COMMON SYNONYMS

p,p' - DDD; 4,4'-Dichlorodiphenyldichloroethane; 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethane; 1,1'-(2,2-Dichloroethylidene)bis[4-chlorobenzene]

ANALYTICAL CLASSIFICATION

Pesticide (organic)

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble (maximum 0.16 mg/L at 25°C) [1]
Vapor Pressure: 10.2×10^{-7} mm Hg at 30°C [1]
Henry's Law Constant: 7.96E-6 atm-m^3/mole [2]
Specific Gravity: 1.385 gm/m^3 [1]
Organic Carbon Partition Coefficient: 770,000 [1]

FATE DATA: HALF-LIVES

Soil: 2 - 15.6 years [3]
Air: 17.7 hours - 7.4 days [3]
Surface Water: 2 - 15.6 years [3]
Groundwater: 70 days - 31.3 years [3]

NATURAL SOURCES

None noted [4].

ARTIFICIAL SOURCES

Contact insecticide; pediculicide [4].

FATE AND TRANSPORT

Like 4,4'-DDE and 4,4'-DDT, 4,4'-DDD is a highly stable compound difficult to remove from soils and waters. It is resistant to photodegradation and/or oxidation [4]. Given the high K_{oc} value, 4,4'-DDD would be expected to adsorb very tightly to soils and sediments/suspended solids in waters. In addition to the high K_{oc}, the low level of solubility suggests little probability of groundwater infiltration via leaching. The low values associated with this compound for vapor pressure and Henry's Law constant suggest little tendency to volatilize from soils or waters. The bioconcentration of similar compounds (namely, 4,4'-DDE and

4,4'-DDT) suggests that this compound is likely to bioconcentrate. Biodegration, aerobic or anaerobic, is expected to be slow [1].

HUMAN TOXICITY

General. Typically, individuals are exposed to a mixture of 4,4'-DDT, 4,4'-DDE and 4,4'-DDD, and not to the compounds individually. Both 4,4'-DDE and 4,4'-DDD are contaminants, as well as degradation and metabolic products, of 4,4'-DDT [1]. Most of the available toxicity data deal with 4,4'-DDT. The major targets of the three compounds are the central nervous system (CNS) and the liver [1]. Data regarding the genotoxicity of the compounds are equivocal [1,5]. The USEPA placed 4,4'-DDT, 4,4'-DDE and 4,4'-DDD in weight-of-evidence cancer Group B2, indicating that they are probable human carcinogens [6].

Oral Exposure. A chronic oral RfD is currently not available for 4,4'-DDD [6]. 4,4'-DDD is readily absorbed following oral exposure [1]. An oral LD_{50} value of 113 mg/kg is reported for rats [5]. Large doses (8-10 g) of 4,4'-DDD have been administered orally for treatment of adrenal cortical cancer and Cushing's syndrome. Side effects resulting from treatment include nausea, vomiting, CNS depression and skin rash [5]. These effects are reversible following termination of treatment. Longer-term administration at doses above 3 g/day may result in adrenal cortical atrophy. The therapeutic use of 4,4'-DDD results from its effect on the metabolism of adrenal steroid hormone [5]. It is not known whether oral exposure to 4,4'-DDD will result in effects on human reproduction or development. There is no evidence that 4,4'-DDD causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [5]. The USEPA derived an oral slope factor of 0.24 $(mg/kg/day)^{-1}$ based on the incidence of liver tumors in mice [6].

Inhalation Exposure. A chronic inhalation RfC is not available for 4,4'-DDD [6]. Inhalation of 4,4'-DDD is considered to be a minor route of entry because 4,4'-DDD is a large particle and, when inhaled, is trapped in the upper regions of the respiratory tract and eventually swallowed [1]. Data are not available regarding the toxicity of inhaled 4,4'-DDD in humans or animals [1].

Dermal Exposure. Dermal LD_{50} values in rabbits range from 1200 to 5000 mg/kg [1,5]. Further information regarding the toxicity of dermal exposure to 4,4'-DDD were not located.

ECOLOGICAL TOXICITY

General. 4,4'-DDD was widely used as an insecticide until 1972, when its use in the United States was banned. However, it is still manufactured and used elsewhere in the world. It is also produced from the anaerobic decomposition of 4,4'-DDT in the environment [7].

As would be expected from this class of compounds, 4,4'-DDD has a high environmental toxicity to invertebrates and is also quite toxic to fish, birds, and mammals. However, the primary concerns related to 4.4'-DDD are its persistence in the environment, its ability to bioconcentrate in almost all classes of biota, and its capacity to biomagnify through the food chain.

Vegetation. Although no data was found on the phytotoxicity of 4.4'-DDD, the risk of this compound to plants is probably low. According to Micromedex, Inc. [8], enough 4,4'-DDT was produced to cover all of the arable land in the world with this compound and its metabolites 4,4'-DDD and 4,4'-DDE at a rate of 1.5 pounds per acre. Despite the abundance of these chemicals, the scientific literature is virtually devoid of information on phytotoxicity. This implies that 4.4'-DDD has low toxicity to plants.

Like 4,4'-DDT, 4.4'-DDD bioconcentrates in aquatic plants. Studies summarized by Micromedex, Inc. [8] show a bioconcentration factor in algae of more than 6.200. Tissue concentrations in aquatic vascular plants of 0.5 μg/kg dry weight were found in Finnish lakes. Although in-tissue concentrations of DDT may not be toxic to the plants, they are important as sources of 4,4'-DDD in higher trophic levels. Concerning the structurally similar compound 4,4'-DDT, Johnson and Finley [9] state that "Food seems to be more important than water as a source of body residues," while a study on DDE (another metabolite of DDT with a similar chemical structure) summarized by the USEPA [7] found concentration factors of 10^4 in mosquito larvae and fish exposed in a food-chain microcosm, but only 10^2 through aquatic exposure where a food chain did not exist.

Aquatic Life. Neither the USEPA nor Ohio has established a criterion for 4.4'-DDD for the chronic protection of freshwater aquatic life. However, because of the chemical similarities between 4.4'-DDD and 4,4'-DDT, it is assumed that the 4.4'-DDT criteria would provide adequate protection if applied to 4,4'-DDD. The federal aquatic life criterion for 4.4'-DDT for the chronic protection of freshwater aquatic life is 0.001 μg/L [10]. The corresponding criterion from the state of Ohio for 4.4'-DDT is also 0.001 μg/L [11].

4,4'-DDD appears to be slightly less toxic to aquatic fauna than 4.4'-DDT. Acute toxicities (96-hour LC_{50}s) for 4,4'-DDD for freshwater aquatic invertebrates summarized by Johnson and Finley [9] and Micromedex, Inc. [8] ranged from 0.6 μg/L to 380 μg/L, with approximately half of the values above 10 μg/L. Acute toxicities for fish ranged between 18 μg/L and 70 μg/L 4,4'-DDD for sensitive species such as walleye, bass, and trout, and to more than 1,500 μg/L for species such as the catfish and fathead minnow [8]. Acute toxicities for 4,4'-DDT for batch invertebrates and fish seldom exceed 10 μg/L.A major concern to aquatic life is the bioconcentration of 4,4'-DDD. Studies reported by the USEPA [7] and Micromedex, Inc. [8] show bioconcentration factors for invertebrates and fish generally ranging from 10^3 to 10^5. Bioaccumulation of 4.4'-DDD is important both because the chemical can build up to toxic concentrations in the animal's tissues and because it serves as a source of toxic levels of 4.4'-DDD to higher trophic levels. The classic example, as reported by the USEPA [7], occurred at Clear Lake, California. This lake was treated three times from 1949 to 1957 with 4,4'-DDD at concentrations of 14 and 20 ppb to control gnats. The deaths of numerous grebes (aquatic birds), found to contain up to 1,600 ppm 4,4'-DDD in their fatty tissue, prompted examination of 4,4'-DDD levels in fish. Analysis of nine fish species from the lake showed concentrations of DDD in edible fish ranging from 5 ppm to 221 ppm, with DDD levels in visceral fat exceeding 2,000 ppm in some samples.

Wildlife. Toxicity of 4,4'-DDD to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents and rabbits. In the body, 4,4'-DDD accumulates chiefly in the adipose tissue, but is also found in significant concentrations in the liver, brain, and muscle tissues [12]. Tissue concentrations of 4,4'-DDD in both wild rabbits and white-tailed deer collected at 4,4'-DDT-treated system fields ranged up to approximately 1.5 ppm and averaged 0.32 ppm for rabbits and 0.62 ppm for deer [8].

Birds are also susceptible to 4,4'-DDD poisoning. Studies summarized in Micromedex Inc. [8] showed that mallards, ring-necked pheasant, bobwhite quail, and Japanese quail had 5-day LD_{50}s for ingestion of 4,4'-DDD ranging from 445 ppm to 4,800 ppm. Bioaccumulation also occurs in birds, as evidenced by the Clear Lake incident cited earlier. In other studies summarized by Micromedex, Inc. [8], dead or moribund bald eagles collected from 32 states had median carcass concentrations of 4,4'-DDD of 10.7 ppm, while ospreys collected from six eastern states had maximum wet weight 4,4'-DDD concentrations of 18 ppm in both brain and carcass. However, the greatest environmental threat to birds from 4,4'-DDD is associated with eggshell thinning and related reproductive failure. Studies cited by Micromedex, Inc. [8] showed 89 percent of bald eagle eggs collected from 1969 to 1979 contained measurable concentrations of 4,4'-DDD, as did 16 percent of black-crowned night heron eggs collected in 1979. Steep decline in populations of birds such as eagles, peregrine falcons, as preys, and brown pelicans that occupy upper trophic levels prompted the United States and many other developed countries to ban the use of 4,4'-DDD and 4,4'-DDT in the early 1970's.

REFERENCES

1. ATSDR. 1989. Toxicological Profile for P,P'-DDT, P,P'-DDE, P,P'-DDD. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
2. USEPA, 1986. Superfund Public Health Evaluation Manual. EPA 540/1-86/060. United States Environmental Protection Agency. Washington, D.C. 175 pp.
3. Howard, .P.H.; Boethling R.S.; Jarvis, W.F.; Meylan, W.M.; and Michalenko, E.M.; 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.
4. Merck, 1989. The Merck Index. Tenth Edition. Merck & Company, Inc. Rahway, NJ.
5. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide, Volume 4. Cambridge, MA. July 1989.
6. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

7. USEPA. 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I: Introduction and Technical Background. Metals and Inorganics. Pesticides and PCB's. Office of Planning and Standards. Office of Water and Waste Management, Washington D.C. EPA-440/4-79-029a.

8. Micromedex. Inc.. 1992. Tomes Plus System. Toxicology. Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.

9. Johnson. W.W., and M.T. Finley. 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior, Fish and Wildlife Service, Resource Publication 137. Washington. D.C.

10. USEPA. 1991. Water Quality Criteria Summary. Washington. D.C.

11. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code. Title 3745-Chapter 1. Ohio Environmental Protection Agency.

12. Sax. N.I. (ed.). 1985. Dangerous Properties of Industrial Materials Report. Van Nostrand Reinhold. New York. Vol.5 (1): 12-20.

4,4'-DDE

CAS NUMBER

72-55-9

COMMON SYNONYMS

p,p' - DDE; 4,4'-Dichlorodiphenylchloroethane; 1.1-Dichloro-2.2-bis(p-ethylphenyl) ethane; 1,1'-(2,2-Dichloroethylidene)bis[4-ethylbenzene] [1]

ANALYTICAL CLASSIFICATION

Pesticide (organic).

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.12 mg/L at 25°C [2]
Vapor Pressure: 6.50 x $10E^{-6}$ mm Hg at 20°C [2]
Henry's Law Constant: 6.8 x 10^{-5} atm-m^3/mole [2]
Specific Gravity: ND [2]
Organic Carbon Partition Coefficient: 4,400.000 [2]

FATE DATA: HALF-LIVES

Soil: 2 - 15.6 years [3]
Air: 17.7 hours - 7.4 days [3]
Surface Water: 15 hours - 6.1 days [3]
Groundwater: 16 days - 31.3 years [3]

NATURAL SOURCES

None noted [1].

ARTIFICIAL SOURCES

Insecticide [1].

FATE AND TRANSPORT

Like 4,4'-DDD and 4,4'-DDT, 4,4'-DDE is a highly stable compound. Generally, it is resistant to photodegradation and/or oxidation [1]. Given the high K_{oc} value, 4,4'-DDE is expected to adsorb tightly to soils and sediments/suspended solids in waters. In addition to the high K_{oc} value, the low level of solubility suggests little probability of groundwater infiltration via leaching through soils. The low vapor pressure and Henry's Law constant values suggest little tendency to volatilize from soils and/or waters. 4,4'-DDE has a high bioconcentration factor (51,000), indicating that it is expected to readily bioconcentrate in aquatic organisms [4]. Biodegradation, aerobic or anaerobic, is expected to be slow.

HUMAN TOXICITY

General. Typically, individuals are exposed to a mixture of 4,4'-DDT, 4,4'-DDE and 4,4'-DDD, and not to the compounds individually. Both 4,4'-DDE and 4,4'-DDD are contaminants, as well as degradation and metabolic products, of 4,4'-DDT [2]. Most of the available toxicity data deal with 4,4'-DDT. The major targets of the three compounds are the central nervous system (CNS) and the liver [2]. Data regarding the genotoxicity of the compounds are equivocal, but chromosomal damage has been observed in exposed individuals [2]. The USEPA placed 4,4'-DDT, 4,4'-DDE and 4,4'-DDD in weight-of-evidence Group B2, indicating that they are probable human carcinogens [6].

Oral Exposure. A chronic oral RfD is currently not available for 4,4'-DDE [6]. 4,4'-DDE is readily absorbed following oral exposure [2]. Acute oral LD_{50} values of 880 to 1240 mg/kg were reported for male and female rats, respectively, and a range of 700 to 1000 mg/kg was reported in mice [5]. Symptoms of acute exposure were not reported, but toxic effects on the liver (necrosis) and CNS (tremors, ataxia, loss of equilibrium) have resulted in animals following long-term oral exposure [5]. In one study in humans, no adverse effects were noted in an individual given 5 mg (0.07 mg/kg/day) 4,4'-DDE orally for 92 days [5]. Limited animal studies indicate that 4,4'-DDE is not likely to affect reproduction or development. There is no evidence that 4,4'-DDE causes cancer in humans, but studies in animals suggest that oral exposure may result in liver cancer [5]. The USEPA derived an oral slope factor of 0.34 $(mg/kg/day)^{-1}$ based on the incidence of liver tumors in animals [6].

Inhalation Exposure. A chronic inhalation RfC is not available for 4,4'-DDE [6]. Inhalation of 4,4'-DDE is considered to be a minor route of entry because 4,4'-DDE is a large particle and, when inhaled, is trapped in the upper regions of the respiratory tract and eventually swallowed [2]. Data are not available regarding the toxicity of inhaled 4,4'-DDE in humans or animals [2].

Dermal Exposure. No useful information was located regarding dermal exposure to 4,4'-DDE.

ECOLOGICAL TOXICITY

General. 4,4'-DDE is an impurity in 4,4'-DDT and also is formed as a degradation product of 4,4'-DDT [7]. It is not manufactured as a commercial product [8]. As would be expected from this class of compounds, 4,4'-DDE has a high environmental toxicity to invertebrates and is also quite toxic to fish, birds, and mammals. However, the primary concerns related to 4,4'-DDE are its persistence in the environment, its ability to bioconcentrate in almost all classes of biota, and its capacity to biomagnify through the food chain. These problems are particularly serious because, unlike 4,4'-DDT and 4,4'-DDD, 4,4'-DDE in biota appears to be a stable end product incapable of being further degraded by biotransformation [8]. This characteristic results in 4,4'-DDE being detected in 90 to 100 percent of fish and bird samples collected throughout the United States at least 11 years after the use of 4,4'-DDT was banned [7].

Vegetation. Although no data were found on the phytotoxicity of DDE, the risk of this compound to plants is probably low. According to Micromedex, Inc. [7], enough 4,4'-DDT was produced to cover all of the arable land in the world with this compound and its metabolites, 4,4'-DDD and 4,4'-DDE, at a rate of 1.5 pounds per acre. Despite the abundance of these chemicals, the scientific literature is virtually devoid of information on phytotoxicity. This implies that 4,4'-DDE has low toxicity to plants.

Like 4,4'-DDT, 4,4'-DDE bioconcentrates in aquatic plants. Studies summarized by the USEPA (1979) and Micromedex, Inc. [7] show bioconcentration factors in algae of 10^3 to 10^4. Tissue concentrations in aquatic vascular plants of 2 µg/kg dry weight were found in Finnish lakes. Although in-tissue concentrations of 4,4'-DDE may not be toxic to the plants, they are important as sources of 4,4'-DDE in higher trophic levels. Concerning the structurally similar compound 4,4'-DDT, Johnson and Finley [9] state that "Food seems to be more important than water as a source of body residues," while a study on DDE summarized by the USEPA [8] found concentration factors of 10^4 in mosquito larvae and fish exposed in a food-chain microcosm, but only 10^2 through aquatic exposure where a food chain did not exist.

Aquatic Life. Neither the USEPA nor the state has established a criterion for 4,4'-DDE for the chronic protection of freshwater aquatic life. However, because of the chemical similarities between 4,4'-DDE and 4,4'-DDT, it is assumed that the 4,4'-DDT criteria would provide adequate protection if applied to 4,4'-DDE. The federal aquatic life criterion for 4,4'-DDT for the chronic protection of freshwater aquatic life is 0.001 µg/L [10]. The corresponding criterion from the state of Ohio for 4,4'-DDT is also 0.001 µg/L [11]. 4,4'-DDE appears to be slightly less toxic to fish than 4,4'-DDT. Acute toxicities (96-hour LC_{50}s) from 4,4'-DDE for freshwater fish summarized by Micromedex, Inc. [7] ranged from 32 µg/L to 240 µg/L. Acute toxicities for 4,4'-DDT for fish seldom exceeded 10 µg/L. No data were found concerning acute toxicities of 4,4'-DDE to aquatic invertebrates. A major concern to aquatic life is the bioconcentration of 4,4'-DDE. Studies reported by the USEPA [8] and Micromedex, Inc. [7] show bioconcentration factors for invertebrates and fish generally ranging from 10^3 to 10^5. Bioaccumulation of 4,4'-DDE is important both because the chemical can build up to toxic concentrations in the animal's tissues and because it serves as a source of toxic levels of 4,4'-DDE to higher trophic levels. In fish collected from Great Lakes watersheds in the early 1980's, 94 percent were positive, with 4,4'-DDE concentrations ranging from 15 to 5,800 ppb [7]. More than 30 percent of snapping turtles from waters in New York had 4,4'-DDE concentrations of greater than 5 ppm [7].

Wildlife. Toxicity of 4,4'-DDE to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents. In the body, 4,4'-DDE accumulates chiefly in the adipose tissue, but is also found in significant concentrations in liver, brain, and muscle tissues [12].

Birds are also susceptible to 4,4'-DDE poisoning. Studies summarized by Micromedex, Inc. [7] showed that mallards, ring-necked pheasant, bobwhite quail, and Japanese quail had 5-day LD_{50}'s for ingestion of 4,4'-DDE ranging from 825 to 3,572 ppm. Bioaccumulation also occurs in birds. In other studies summarized by Micromedex, Inc. [7], 100 percent of 293 dead or moribund bald eagles collected in the United States from 1978 through 1981 tested positive for 4,4'-DDE and had median carcass concentrations of 4,4'-DDE each year of 2.4 to 3.3 ppm. Mean 4,4'-DDE concentrations in Pacific black ducks were 331 ppm in fat, 42 ppm in wings, 10 ppm in liver, and 2.1 ppm in brain [7]. However, the greatest environmental threat to birds from 4,4'-DDE is associated with eggshell thinning and related reproduction failure. Studies cited by Micromedex, Inc. [7] showed 100 percent of black-crowned night heron eggs collected from Colorado and Wyoming in 1979 contained concentration of 4,4'-DDE ranging from 0.33 to 44 ppm (wet weight) as did 98 percent of colonial waterbirds eggs collected from Green Bay and Lake Michigan between 1975 and 1980 (0.30 to 44 ppm wet weight). Steep declines in populations of birds such as eagles, peregrine falcons, ospreys, and brown pelicans that occupy upper trophic levels prompted the United States and many other developed countries to ban the use of 4,4'-DDT in the early 1970's.

REFERENCES

1. Merck, 1989. The Merck Index. Tenth Edition. Merck & Company, Inc. Rahway, NJ.
2. ATSDR, 1989. Toxicological Profile for P,P'-DDT, P,P'-DDE, P,P'-DDD. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
3. Howard, P.H.; Boethling R.S.; Jarvis, W.F.; Meylan, W.M.; and Michalenko, E.M.; 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.
4. USEPA, 1986. Superfund Public Health Evaluation Manual. EPA 540/1-86/060. United States Environmental Protection Agency. Washington, D.C. 175 pp.
5. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide. Volume 4. Cambridge, MA. July 1989.
6. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
7. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.
8. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I: Introduction and Technical Background, Metals and Inorganics, Pesticides and PCB's.

Office of Planning and Standards. Office of Water and Waste Management. Washington D.C. EPA-440/4-79-029a.

9. Johnson. W.W., and M.T. Finley, 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior. Fish and Wildlife Service, Resource Publication 137. Washington. D.C.
10. USEPA, 1991. Water Quality Criteria Summary. Washington. D.C.
11. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code-Title 3734-Chapter 1. Ohio Environmental Protection Agency.
12. Sax, N.I. (ed.), 1985. Dangerous Properties of Industrial Materials Report. Van Nostrand Reinhold. New York. Vol.5 (1): 12-20.

4,4'-DDT

CAS NUMBER

50-29-3

COMMON SYNONYMS

p,p' - DDT; 4,4'-Dichlorodiphenyltrichloroethane, 1,1-(2,2,2-Trichloroethylidene)bis[4-chlorobenzene]

ANALYTICAL CLASSIFICATION

Pesticide (organic).

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble (maximum 0.0034 mg/L at 25°C) [1]
Vapor Pressure: 5.5×10^{-6} mm Hg at 20°C [1]
Henry's Law Constant: 5.13×10^{-4} atm-m^3/mole [1]
Specific Gravity: 0.98 - 0.99 gm/ml at 20°C [2]
Organic Carbon Partition Coefficient: 243,000 [1]

FATE DATA: HALF-LIVES

Soil: 2 - 15.6 years [3]
Air: 17.7 hours - 7.4 days [3]
Surface Water: 7 - 350 days [3]
Groundwater: 16 days - 31.3 years [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Contact insecticide, pesticide [2].

FATE AND TRANSPORT

Like 4,4'-DDD and 4,4'-DDE, 4,4'-DDT is a highly stable compound and is considered a persistent pollutant in soils and waters. It is generally resistant to photodegradation and/or oxidative processes [4]. Given the high K_{oc} value, 4,4'-DDT is expected to adsorb very tightly to soils, sediments and suspended solids in waters. In addition to the high K_{oc} value, the low level of solubility suggests little probability of groundwater infiltration via leaching. The low values associated with this compound for vapor pressure and Henry's Law constant suggest little tendency to volatilize from soils or waters. The bioconcentration factor

(54,000) associated with this compound suggests a readiness to bioconcentrate in aquatic organisms [5]. Biodegradation, aerobic or anaerobic, is expected to be slow [1].

HUMAN TOXICITY

General. Typically, individuals are exposed to a mixture of 4,4'-DDT, 4,4'-DDE and 4,4'-DDD, and not to the compounds individually. Both 4,4'-DDE and 4,4'-DDD are contaminants, as well as degradation and metabolic products, of 4,4'-DDT [1]. Most of the available toxicity data deal with 4,4'-DDT. The major targets of the three compounds are the central nervous system and the liver [1]. Data regarding the genotoxicity of the compounds are equivocal [1,2]. The USEPA placed 4,4'-DDT, 4,4'-DDE and 4,4'-DDD in weight-of-evidence Group B2, indicating that they are probable human carcinogens [6].

Oral Exposure. A chronic oral RfD of 0.0005 mg/kg/day is based on a NOEL of 0.05 mg/kg/day for liver lesions in a subchronic oral study in rats [6]. 4,4'-DDT is readily absorbed following oral exposure [1]. Oral LD_{50} values in animals ranged from 87 mg/kg in rats to 400 mg/kg in guinea pigs [1,2]. The human oral LD_{50} value has been estimated at 250 mg/kg [2]. The initial symptoms of oral poisoning include a burning or prickling sensation of the mouth and face, tremor of the extremities, confusion, malaise, headache, fatigue and delayed vomiting [2]. These symptoms can occur as soon as 30 minutes after the ingestion of a large dose or as long as 6 hours after the ingestion of a small dose. Recovery is usually complete within 24 hours after poisoning. Several longer-term studies have been conducted in humans [2]; no adverse effects were observed following treatment with up to 35 mg daily (0.5 mg/kg/day) for 21.5 months. Pathological lesions of the liver and kidneys were reported in chronic studies in animals [2]. There is no evidence that 4.4'-DDT affects reproduction or development in humans [1]. There is no evidence that 4.4'-DDT causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [1]. The USEPA derived an oral slope factor of 0.34 $(mg/kg/day)^{-1}$ based on the incidence of liver tumors in mice [6].

Inhalation Exposure. A chronic inhalation RfC is not available for 4,4'-DDT [6]. Inhalation of 4,4'-DDT is considered to be a minor route of entry because 4,4'-DDT is a large particle and, when inhaled, is trapped in the upper regions of the respiratory tract and eventually swallowed [1]. In occupationally exposed workers, no overt symptoms of exposure were reported, although an increase in neurological effects was suggested [2]. Daily intake in workers was estimated to be approximately 18 mg/man (0.25 mg/kg/day) [2]. Limited, short-term inhalation studies in animals indicate that the central nervous system is the target of 4,4'-DDT toxicity [2]. An inhalation unit risk of 9.7×10^{-5} was calculated from the oral slope factor [6].

Dermal Exposure. Dermal LD_{50} values ranged from 300 mg/kg in rabbits to 3000 mg/kg in rats [1,2]. Dermal contact with 4,4'-DDT does not appear to cause irritation or systemic effects [2].

ECOLOGICAL TOXICITY

General. 4,4'-DDT was widely used as an insecticide until 1972, when its use in the United States was banned. However, it is still manufactured and used elsewhere in the world. As would be expected from this class of compounds, 4,4'-DDT has a high environmental toxicity to invertebrates and is also quite toxic to fish, birds, and mammals. However, the primary concerns related to 4,4'-DDT are its persistence in the environment, its ability to bioconcentrate in almost all classes of biota, and its capacity to biomagnify through the food chain.

Vegetation. Although no data were found on the phytotoxicity of 4,4'-DDT, the toxicity of this compound to plants is probably low. Since the 1940's, more than 3.5 billion pounds of 4,4'-DDT have been produced, which is an amount sufficient to cover all of the arable land in the world at the rate of 1.5 pounds per acre [7]. Because of the environmental persistence of DDT and its metabolites, this application rate would have resulted in a concentration of 4,4'-DDT, 4,4'-DDD, and/or 4,4'-DDE of approximately 750 μg/kg in arable surface soils worldwide. Despite the abundance of these chemicals, the scientific literature is virtually devoid of information on phytotoxicity. This implies that 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE have low toxicities to plants. 4,4'-DDt bioconcentrates in many species of aquatic plants. Studies summarized by Micromedex, Inc. [7] show a bioconcentration factor in *Cladophora* (a green algae) of more than 21,000. Bioconcentration factors in aquatic vascular plants range from approximately 500 to 14,000. Although in-tissue concentrations of 4,4'-DDT may not be toxic to the plants, they are important as sources of 4,4'-DDT in higher trophic levels. Johnson and Finley [8] state that "Food seems to be more important than water as a source of body residues," while a study on DDE (a metabolite of 4,4'-DDT with a similar chemical structure) summarized by the USEPA [9] found concentration factors of 10^4 in mosquito larvae and fish exposed in a food-chain microcosm, but only 10^2 through aquatic exposure where a food chain did not exist.

Aquatic Life. The federal aquatic life criterion for 4,4'-DDT for the chronic protection of freshwater aquatic life is 0.001 μg/L [10]. The corresponding state criterion from Ohio for 4,4'-DDT is also 0.001 μg/L [11].

These standards derive from the high toxicity of 4,4'-DDT to aquatic invertebrates and fish. For example, studies cited in Johnson and Finley [8] and Micromedex, Inc. [7] show most 96-hour LC_{50}s (acute toxicities) for both invertebrates and fish between 1 and 10 μg/L. Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [12].

A major concern to aquatic life is the bioconcentration of 4,4'-DDT. Numerous studies reported by the USEPA [9] and Micromedex, Inc. [7] show bioconcentration factors for invertebrates and fish generally ranging from 10^3 to 10^5. Residue accumulations in fish of up to 2 million have been reported [12]. Bioaccumulation of 4,4'-DDT is important both because the chemical can build up to toxic concentrations in the animal's tissues and because it serves as a source of toxic levels of 4,4'-DDT to higher trophic levels.

Wildlife. Toxicity of 4,4'-DDT to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents and rabbits. In the body, 4,4'-DDT and its metabolites accumulate chiefly in the adipose tissue, but are also found in significant concentrations in the liver, brain, and muscle tissues [13]. Cattle and swine fed 25 ppm in the diet for 28 days had 4,4'-DDT levels in fat of 22 ppm and 10 ppm, respectively [13].

Birds are also susceptible to 4,4'-DDT poisoning. Studies summarized by Micromedex, Inc. [7] showed that mallards, ring-necked pheasant, bobwhite quail, and Japanese quail had 5-day LD_{50}s for ingestion of 4,4'-DDT ranging from 300 ppm to 4800 ppm. Bioaccumulation also occurs in birds, with mean wet weight concentrations in muscle tissue from gamebirds (goose, quail, and woodcock) in several Tennessee counties ranging from 2.9 mg/kg to 9.9 mg/kg [14]. Bald eagle carcasses showed 4,4'-DDT concentrations as high as 25 ppm (lipid basis), while ospreys accumulated 4,4'-DDT up to 5.7 ppm (wet weight) [7]. However, the greatest environmental threat to birds from 4,4'-DDT and its metabolites is associated with eggshell thinning and associated reproductive failure. Studies cited by the USEPA [12] showed that dietary intake of 4.4'-DDT at more than 3 mg/kg wet weight in natural food adversely affected reproduction in captive waterfowl. By the late 1960's, populations of birds occupying upper trophic levels, such as eagles, peregrine falcons, ospreys, and brown pelicans, had declined sharply because of eggshell thinning caused by 4,4'-DDT and its metabolites in the natural diet. Concerned about these declining populations lead the United States and many other developed countries to ban to use of 4,4'-DDT in the early 1970's.

REFERENCES

1. ATSDR, 1989. Toxicological Profile for P,P'-DDT, P,P'-DDE, P,P'-DDD. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
2. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide. Volume 4. Cambridge, MA. July 1989.
3. Howard, P.H.; Boethling R.S.; Jarvis, W.F.; Meylan, W.M.; and Michalenko, E.M.; 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.
4. Merck, 1989. The Merck Index. Tenth Edition. Merck & Company, Inc. Rahway, NJ.
5. USEPA, 1986. Superfund Public Health Evaluation Manual. EPA 540/1-86/060. United States Environmental Protection Agency. Washington, D.C. 175 pp.
6. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

7. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.
8. Johnson, W.W., and M.T. Finley. 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior, Fish and Wildlife Service. Resource Publication 137. Washington, D.C.
9. USEPA. 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I: Introduction and Technical Background, Metals and Inorganics, Pesticides and PCB's. Office of Planning and Standards, Office of Water and Waste Management. Washington D.C. EPA-440/4-79-029a.
10. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
11. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
12. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
13. Sax, N.I. (ed.), 1985. Dangerous Properties of Industrial Materials Report. Van Nostrand Reinhold, New York. Vol.5 (1): 12-20.
14. Verschueren, K., 1983. Handbook of Environmental Data of Organic Chemicals. Second Edition. Van Nostrand Reinhold Co., New York, New York.

DIBENZOFURAN

CAS NUMBER

132-64-9

COMMON SYNONYMS

Diphenylene Oxide

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 10 mg/L at 25°C [1]
Vapor Pressure: 0.0044 mm Hg at 25°C [1]
Henry's Law Constant: 9.73×10^{-5} atm-m^3/mole [1]
Specific Gravity: 1.0886 at 99/4°C [1]
Organic Carbon Partition Coefficient: 4,600 - 6,350 [1]

FATE DATA: HALF-LIVES

Soil: 7 days to 4 weeks [2]
Air: 1.9 to 19 hours [2]
Surface Water: 7 days to 4 weeks [2]
Groundwater: 8.5 to 35 days [2]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Atmospheric emissions result from the combustion of coal, biomass, refuse and diesel fuel. Wastewater emissions from coal tar, coal gasification and shale oil operations [1].

FATE AND TRANSPORT

Dibenzofuran will have very low mobility in soil, and significant leaching is not expected. Dibenzofuran is biodegraded readily by microbes in the presence of sufficient oxygen. In low-oxygen environments, biodegradation may occur very slowly. If released to water, dibenzofuran may partition to sediments and suspended material. Volatilization from water may also be an important process. In the air, dibenzofuran will exist primarily in the gas phase where it will rapidly degrade by reaction with hydroxyl radicals. A small percentage of dibenzofuran in air will be in the particle phase. Removal from air may occur via both dry and wet deposition. Significant bioconcentration of dibenzofuran in aquatic organisms is expected to occur [1]

HUMAN TOXICITY

No useful information was located regarding the toxicity of dibenzofuran in humans or animals following any route of exposure. The HEAST indicates that data for dibenzofuran are inadequate for quantitative risk assessment [3], but IRIS states that a chronic inhalation RfC for dibenzofuran is currently under review [4].

Dibenzofuran has been placed in weight-of-evidence cancer Group D, indicating that it is not classifiable as to human carcinogenicity [3].

REFERENCES

1. USEPA. 1992. Hazardous Substances Data Base (HSDB). Online. July 20. 1992.
2. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
3. USEPA. 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
4. USEPA. 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.

DI-n-BUTYLPHTHALATE

CAS NUMBER

84-74-2

COMMON SYNONYMS

Butyl phthalate

ANALYTICAL CLASSIFICATION

Semivolatile-Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 8.7 to 13 mg/L at 20°C [1]
Vapor Pressure: 1.0×10^{-5} to 1.4×10^{-5} mm Hg at 25°C [1]
Henry's Law Constant: 2.8×10^{-7} 4.6×10^{-7} atm-m^3/mole [1]
Specific Gravity: 1.047 at 20/4°C [1]
Organic Carbon Partition Coefficient: 169,824 [1]

FATE DATA: HALF-LIVES

Soil: 2 to 23 days [2]
Air: 7.4 hours to 3.1 days [2]
Surface Water: 1 to 14 days [2]
Groundwater: 2 to 23 days [2]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Di-n-butylphthalate (DBP) is most commonly used as a plasticizer for epoxy resins and polyvinyl chloride (PVC). It is also used in carpet-back coatings, as a concrete additive, as an insect repellent, and can be found in cosmetics [3].

FATE AND TRANSPORT

DBP can be released into the environment through emissions and in wastewater during the manufacture, use, and burning of materials containing it. In water, it will adsorb moderately to particulates and sediment. Pollution in water affects biodegradation, with DBP disappearing more rapidly in moderately polluted water bodies. Biodegradation in soils is slow, and once spilled, it will moderately adsorb. When introduced to groundwater, it will degrade under anaerobic conditions. Vapor phase DBP is subject to degradation through the reaction with photochemically produced hydroxyl radicals. [4]

HUMAN TOXICITY

General. There is no reliable information that DBP has caused adverse health effects in humans. The most serious health effects of this compound, as revealed by animal studies, are associated with its ability to interfere with normal reproduction [1]. The USEPA has placed DBP in weight-of-evidence Group D, indicating that it is not classifiable as to carcinogenicity [5].

Oral Exposure. A chronic RfD of 0.1 mg/kg/day is based on a NOAEL of 125 mg/kg/day and a LOAEL of 600 mg/kg/day for increased mortality in a rat subchronic to chronic oral bioassay [5]. Animal studies indicate that DBP is rapidly and extensively absorbed by the oral route. Absorption of up to 100% of an orally-administered dose was reported for rats. DBP is of low acute toxicity. The acute oral LD_{50} is reportedly in excess of 20,000 mg/kg. Developmental effects, as well as minor liver and kidney effects have been noted in animals following oral administration. Rats receiving 600 mg/kg/day or more while pregnant had an increased number of fetal resorptions. Pregnant rats receiving 1,000 mg/kg/day during gestation experienced complete reproductive failure. Oral exposure of male rats for 7 days at a dose of 1,000 mg/kg resulted in decreased testicular weight and decreased sperm count [1].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for DBP [5,6]. No reliable information was located regarding the absorption of DBP following inhalation exposure in either humans or animals. The health effects reportedly caused in animals following inhalation exposure were minor [1].

Dermal Exposure. DBP appears to be reasonably well absorbed at a slow, steady rate across the skin. The 90-day dermal LD_{50} for rabbits was reported to be greater than 4,200 mg/kg/day. Slight kidney damage was also noted at this dose rate. A NOAEL of 2,100 mg/kg/day was identified. In rabbits, a single dermal application of 520 mg/kg/day was reported to be slightly irritating to skin and "quite irritating" to mucous membranes [1].

ECOLOGICAL TOXICITY

General. Di-n-butylphthalate (DBP) is a member of the phthalate ester group. Most information found in the technical literature dealt with phthalate esters as a group. Autian [7] suggests there is evidence that phthalate esters are degraded by microbiota and metabolized by fish and animals. As a result, phthalate esters are not likely to biomagnify. DBP has a very low volatility, is strongly absorbed to soil, and has a high potential for bioaccumulation [8].

Vegetation. Arthur D. Little, Inc. [8] estimates that all (99.97 percent) DBP would be sorbed on soil. Corn plants showed decreased growth at 2,000 $\mu g/g$ soil concentration, but no effects were reported at 200 $\mu g/g$ [9]. Review of the technical literature did not produce any other information regarding the phytotoxic effects of DBP.

Aquatic Life. DBP is rapidly metabolize in fish reducing its capability to bioconcentrate. Invertebrates accumulated DBP up to 6,700 times when exposed to water concentrations ranging from 0.08 to 0.3 $\mu g/L$ [10]. The USEPA [9] cited the 96-hour LC_{50} for aquatic organisms at 100-1,000 ppm. The 96-hour LC_{50} values are 1.3 ppm for fathead minnow, 0.73 ppm for bluegill, and greater than 10 ppm for crayfish [11]. Fathead minnow embryos did not survive exposure to 1.8 mg/L DBP. Hatching and larval survival were affected by exposure to 1.0 mg/L DBP, but not to 0.56 mg/L [11]. There are no USEPA chronic or acute aquatic life water quality criteria [12]. The OEPA aquatic life water quality criterion is 190 $\mu g/L$ for warmwater and modified warmwater habitats [13].

Wildlife. Tests show there is a low order of acute toxicity in experimental animals. Rats maintained for three generations on diets containing 300 to 500 mg/kg/day or for five generations on diets containing 100 mg/kg/day experienced no adverse effects [8]. The oral LD_{50} values are 1200 to 12,000 mg/kg body weight for rats, 5282 mg/kg for mice, and 1000 mg/kg for rabbits [14]. Mallard ducks fed a diet containing 10 mg/kg of DBP showed no significant accumulation after 5 months of continuous dietary exposure [11].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Di-n-Butylphthalate. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1990.
2. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
3. Arthur D. Little, Inc., 1987. The Installation Restoration Program Toxicology Guide. Volume 2. Cambridge, MA. June 1987.
4. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. I: Large Production and Priority Pollutants. Lewis Publishers, Inc. Chelsea, Michigan. 574 pp.
5. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
7. Autian, J., 1973. Toxicity and health threats at phthalate esters: review of literature. Environmental Health Perspectives. Vol. 4:3-26.
8. Arthur D. Little, Inc., 1985. The Installation Restoration Program Toxicology Guide. Volume 1. Cambridge, MA.

9. USEPA. 1979. Water Related Environmental Fate of 129 Priority Pollutants. Vol. II. Office of Water and Waste Management, Washington, D.C. EPA-440/4-79-029.

10. Johnson, W.W. and M.T. Finley, 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior, Fish and Wildlife Service. Resource Publication 137.

11. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.

12. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.

13. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.

14. Sax, N.I., 1984. Dangerous Properties of Industrial Materials. 6th ed. Van Nostrand Reinhold, New York. p. 641.

DIETHYL PHTHALATE

CAS NUMBER

84-66-2

COMMON SYNONYMS

Diethyl phthalate; Ethyl phthalate

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1,080 mg/L at 25°C [1]
Vapor Pressure: 1.65 x 10^{-3} mm Hg at 25°C [1]
Henry's Law Constant: 4.8 x 10^{-7} atm-m^3/mole [1]
Specific Gravity: 1.120 at 25/25°C [2]
Organic Carbon Partition Coefficient: 94 - 526 [1]

FATE DATA: HALF-LIVES

Soil: 3 days - 8 weeks [3]
Air: 21 hours - 8.8 days [3]
Surface Water: 3 days - 8 weeks [3]
Groundwater: 6 days - 16 weeks [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

It is primarily used as a plasticizer for cellulosic plastics. It has also been used as a fixative for perfumes, as a solvent to cellulose acetate in varnishes, and as an alcohol denaturant [4].

FATE AND TRANSPORT

DEP most often enters the environment through plastic materials containing DEP. Air, water, and soil are potential targets, with volatilization and leaching the primary routes of transport. When released to both soil and water, DEP biodegrades under aerobic conditions. Oxidation, chemical hydrolysis and volatilization are not expected to be important processes from wet soil. DEP may volatilize from dry soil. The Henry's Law Constant suggests volatilization may occur in shallow water bodies as opposed to deeper water bodies. Bioaccumulation is not expected to be significant. When released to the atmosphere, the vapor form of DEP is emitted and adsorbs to airborne particles. Removal via particulate settling and precipitation is expected to occur [1].

HUMAN TOXICITY

General. Both the acute and chronic toxicity of DEP appear to be very low [4]. DEP is considered to be nonmutagenic and information regarding the carcinogenicity of DEP are not available [4]. DEP has been placed in weight-of-evidence cancer Group D, indicating that it is not classifiable as to human carcinogenicity [5].

Oral Exposure. A chronic oral RfD of 0.8 mg/kg/day is based on a NOAEL of 750 mg/kg/day for decreased growth rate and food consumption. and altered organ weights in a subchronic study in rats [5]. DEP is absorbed following oral exposure, but the extent of absorption is not known. Acute oral LD_{50} values of 8600 mg/kg for rats and 6172 mg/kg for mice were reported [4]. Information regarding the short- or long-term effects of ingested DEP in humans is not available. Animal studies indicate that ingested DEP has low toxicity, with effects on growth and organ weights reported only at high doses [4,5]. There is no information regarding effects of ingested DEP on reproduction or development in humans or animals. Teratogenic effects were reported in animals, however, following intraperitoneal administration of DEP. An oral Slope Factor for cancer is not available for DEP [5].

Inhalation Exposure. A chronic inhalation RfC for DEP is not available [5]. It is not known if DEP is absorbed following inhalation exposure because the only reported effects observed following inhalation exposure are portal-of-entry effects (respiratory system effects) [4,6]. An acute inhalation LC_{50} value of 7510 mg/m^3 was reported for rats [4]. Inhaled DEP has not been reported to be fatal to humans. Exposure to heated vapors of DEP may result in transient irritation of the nose and throat [6]. Other reported symptoms of toxicity include conjunctivitis, corneal necrosis, respiratory tract irritation, dizziness, nausea and eczema [6]. There is no information regarding effects of inhaled DEP on reproduction or development in humans or animals. Teratogenic effects were reported, however, in animals following intraperitoneal administration of DEP. An inhalation Unit Risk for cancer is not available for DEP [5].

Dermal Exposure. An acute dermal LD_{50} value of 3000 mg/kg was reported for guinea pigs [4]. No other useful information was located regarding effects in humans or animals following dermal exposure to DEP.

REFERENCES

1. Howard, P.H., 1990. Handbook of environmental Fate and Exposure Data for Organic Chemicals, Vol. I: Large Production and Priority Pollutants. Lewis Publishers, Inc. Chelsea, Michigan.
2. Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company, New York.

3. Howard, P.H.. Boethling. R.S.. Jarvis. W.F.. Meylan. W.M.. Michaelenko. E.M.. 1990. Handbook of Environmental Degradation Rates. Lewis Publishers. Inc. Chelsea. Michigan. 574 pp.
4. Arthur D. Little, Inc.,1987. The Installation Restoration Program Toxicology Guide. Volume 2. Cambridge, MA. June 1987.
5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March. 1995.
6. Sittig, M., 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Second Edition. Noyes Publications. Park Ridge. New Jersey.

DI-N-OCTYLPHTHALATE

CAS NUMBER

117-84-0

COMMON SYNONYMS

Dioctyl phthalate; Octyl phthalate

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.285 mg/L at 24°C [1]
Vapor Pressure: 1.2 mm Hg at 200°C [1]
Henry's Law Constant: 2.2×10^{-4} atm-m^3/mole [2]
Specific Gravity: 0.99 at 20/20°C [1]
Organic Carbon Partition Coefficient: 19,000 [2]

FATE DATA: HALF-LIVES

Soil: 7 days - 4 weeks [3]
Air: 4.5 hours - 1.9 days [3]
Surface Water: 7 days - 4 weeks [3]
Groundwater: 14 days - 1 year [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Emissions from the manufacture, recycling and processing of plastics; leaches from plastic tubing, containers, etc.; used as organic pump fluid [1].

FATE AND TRANSPORT

Given its high K_{oc} value, di-n-octylphthalate will strongly adsorb to soils and sediment and is unlikely to leach to groundwater. Di-n-octylphthalate will slowly biodegrade with acclimation. Some volatilization from environmental media will occur and aerobic biodegradation may be extensive. Di-n-octylphthalate will bioconcentrate in aquatic organisms, especially in species where little or no metabolism occurs. If released to air, di-n-octylphthalate will be primarily in aerosol form and will be subject to gravitational settling and photodegradation by hydroxy radicals [1,2].

HUMAN TOXICITY

General. Very little information is available regarding the toxicity of di-n-octylphthalate in humans or animals. There is no evidence that di-n-octylphthalate is mutagenic or carcinogenic in humans or animals. Di-n-octylphthalate has not been placed in a weight-of-evidence group by the USEPA [4].

Oral Exposure. A chronic oral RfD of 0.02 mg/kg/day is based on a LOAEL of 175 mg/kg/day for increased liver and kidney weight and increased SGOT and SGPT activity in a subchronic study in rats [5]. Di-n-octylphthalate is absorbed following oral exposure, but the extent of absorption is not known. An acute oral LD_{50} value of 6513 mg/kg was reported for mice [6]. It is not known if ingested di-n-octylphthalate is fatal to humans. There is no evidence that ingested di-n-octylphthalate causes reproductive or developmental effects in humans or animals, but teratogenic effects have been reported following intraperitoneal injection in animals [7]. An oral Slope Factor for cancer is not available for di-n-octylphthalate [4].

Inhalation Exposure. Information regarding effects resulting from the inhalation of di-n-octylphthalate have not been reported in humans or animals. Consequently, a chronic inhalation RfC and an inhalation Unit Risk for cancer are not available [4].

Dermal Exposure. Di-n-octylphthalate is a skin and eye irritant in animals [6].. Further information regarding toxic effects of di-n-octylphthalate following dermal exposure are not available.

ECOLOGICAL TOXICITY

General. Di-n-octylphthalate is one of the least studied phthalate esters. Most information found in the technical literature dealt with phthalate esters as a group. Autian [8] suggests there is evidence that phthalate esters are degraded by microbiota and metabolized by fish and animals. As a result, phthalate esters are not likely to bioconcentrate or biomagnify.

Vegetation. Review of the technical literature did not produce information regarding the phytotoxic effects of di-n-octylphthalate.

Aquatic Life. McCarthy and Whitmore [9] reported that exposure of embryos and larvae of fathead minnows to di-n-octylphthalate at concentrations as high as 10 mg/L did not affect survival of either life stage. Hatching, however, was significantly decreased at 10 mg/L but not at 3.2 mg/L. There are no USEPA or OEPA aquatic life water quality criteria established for di-n-octylphthalate [10,11].

Wildlife. Review of the technical literature produced little information regarding toxicity of wildlife to di-n-octylphthalate. Sax [12] reported an oral LD_{50} for mice as 6,513 mg/kg.

REFERENCES

1. Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company, New York.
2. USEPA, 1992a. Hazardous Substances Data Base (HSDB). Online. August 7, 1992.
3. Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., Michalenko, E.M., 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
5. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
6. Sax, N.I., 1984. Dangerous Properties of Indistrial Materials. Sixth Edition. Van Nostrand Reinhold Company. New York.
7. Sittig, M., 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Second Edition. Noyes Publications. Park Ridge, New Jersey.
8. Autian, J., 1973. Toxicity and health threats of phthalate esters: review of literature. Environmental Health Perspect. 4:3-26.
9. McCarthy, J.F. and D.J. Whitmore, 1985. Chronic toxicity of di-n-butyl and di-n-octyl phthalate to *Dapnia magna* and the fathead minnows. Environ. Toxicol. Chem. 4:167-179.
10. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
11. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
12. Sax, N.I., 1984. Dangerous Properties of Industrial Materials. 6th ed. Van Nostrand Reinhold, New York. p. 641.

ENDOSULFAN/ENDOSULFAN SULFATE

GENERAL

Endosulfan is a widely-used insecticide. It is a mixture of two isomers, known as endosulfan I (a-endosulfan) and endosulfan II (b-endosulfan) [1]. The information presented below pertains to the mixed isomers unless otherwise specified.

CAS NUMBERS

Endosulfan	115-29-7
Endosulfan I	959-98-8
Endosulfan II	33213-65-9
Endosulfan Sulfate	1031-07-8

COMMON SYNONYMS

Endosulfan: Thiodan, [1].

Endosulfan I: a-Endosulfan, a-Thiodan, [1].

Endosulfan II: Endosulfan, b-endosulfan, b-Thiodan, [1].

ANALYTICAL CLASSIFICATION

Pesticide.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.45 to 0.51 mg/L at 20°C [2]
Vapor Pressure: 1.0×10^{-5} mm Hg at 25°C [2]
Henry's Law Constant: 1.0×10^{-5} atm-m^3/mole at 25°C [1]
Specific Gravity: 1.75 [3]
Organic Carbon Partition Coefficient: 3,162 [1]

FATE DATA: HALF-LIVES

For the technical-grade mixture of endosulfan (approximately 64-76% endosulfan I and 29-32% endosulfan II).

Soil: 4.5 hours to 9.1 days [4]
Air: 2.5 to 24.8 hours [4]
Surface Water: 4.5 hours to 9.1 days [4]
Groundwater: 4.5 hours to 9.1 days [4]

NATURAL SOURCES

None [1].

ARTIFICIAL SOURCES

Non-systemic, contact insecticide. [3,5]

FATE AND TRANSPORT

Endosulfan is a colorless-to-brown crystalline solid with a sulfur dioxide odor. Technical endosulfan is composed of a-endosulfan (64 to 76%) and b-endosulfan (29 to 32%). For releases of endosulfan to soil, the primary removal/transport mechanisms will be hydrolysis and biodegradation, especially under alkaline conditions. In addition, endosulfan deposited upon the soil surface may photolyze. Given the low level of water solubility and the low sorptive capability of endosulfan, volatilization and leaching to groundwaters are not expected to be significant. For releases to surface waters, hydrolysis under alkaline conditions is expected to proceed readily; neutral and acidic waters slow the rate of hydrolysis. Biodegradation and volatilization from surface waters should also be significant removal/transport mechanisms. Products of biodegradation and/or abiotic degradation include endosulfan sulfate (the primary metabolite) under aerobic conditions, and endosulfan diol and endosulfan-a-hydroxy ether under anaerobic (methanogic) conditions. Finally, oxidation of endosulfan in waters may also be expected, to a lesser degree. Given the high K_{oc} (values from 2,344 to 6,761) and BCF (values from 2,754 to 28,840) for endosulfan, its isomers, and the primary metabolite (endosulfan sulfate), bioconcentration in aquatic organisms is expected to be significant. Atmospheric concentrations of endosulfan are predicted to undergo reaction with photochemically-produced hydroxyl radicals. Adsorption of endosulfan onto particulate matter may increase the atmospheric residence time. In addition, photolysis may also prove to be a removal mechanism for atmospheric endosulfan.

Of the two isomers endosulfan I exhibits a greater potential for bioconcentration, sorption to organic matter, and, therefore, a more limited mobility from soils to groundwater or surface water (via leaching and runoff). The main product of degradation, endosulfan sulfate, exhibits this trait of immobility and bioconcentratibility as well [2].

HUMAN TOXICITY

General. Endosulfan has caused nervous system damage and death in humans and animals. Adverse effects to the liver, kidney, blood, immune system, and reproductive organs have also been observed in laboratory animals [1]. The USEPA has not evaluated endosulfan for evidence of human carcinogenicity [6,7].

Oral Exposure. A chronic oral RfD of 0.006 mg/kg/day is based on a NOAEL of 0.6 mg/kg/day for reduced body weight gain and increased instances of marked progressive glomerulonephrosis and blood vessel aneurysms in a chronic study in rats, and a NOAEL of 0.57 mg/kg/day for decreased weight gain and neurological findings in a subchronic study in dogs [6]. There is indirect evidence that endosulfan is absorbed following ingestion by humans. Studies in mice indicated that absorption could be as high as 78% and 85% for a-and b-endosulfan, respectively. The acute oral LD_{50} in rats ranges from 76 mg/kg for a-endosulfan to 240 mg/kg for b-endosulfan. In laboratory animals ingestion has resulted in damage to the nervous system, lungs, blood, liver, kidney, immune system, and reproductive organs in both males and females. Adverse developmental effects have also been noted. A number of human deaths have been attributed to ingestion of endosulfan, but the amounts have not been quantified. The symptoms of exposure included gagging, vomiting, diarrhea, agitation, writhing, unconsciousness, cyanosis, dyspnea, foaming of the mouth, and noisy breathing. In one case of attempted suicide, approximately 60 mg (roughly 0.86 mg/kg) was ingested by a 20-year-old man. Tachycardia, hypertension, and cardiogenic shock followed. Respiratory distress lasted about 2 weeks. [1].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for endosulfan [6,7]. Indirect evidence indicates that endosulfan is absorbed following inhalation in both humans and animals. A 4-hour LC_{50} value of 350 mg/m^3 was reported for male rats. Details on this study are lacking. Adverse neurological effects have been observed in humans following inhalation of endosulfan. However, confounding factors in these studies (e.g., chronic alcohol consumption) limit their usefulness [1].

Dermal Exposure. Animal studies provide indirect evidence that endosulfan is absorbed following dermal exposure. The dermal LD_{50} in rabbits has been reported to range from 167 to 182 mg/kg. The most prominent signs of acute overexposure to endosulfan following dermal contact are neurological; that is, muscle tremors, hyperactivity, and convulsions. Adverse effects on the liver, kidney, and blood have also been noted following dermal exposure in experimental animals [1].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Endosulfan, Endosulfan Alpha, Endosulfan Beta, Endosulfan Sulfate. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.

2. Howard, P.H., 1991. Handbook of Environmental Fate and Degradation Rates for Organic Chemicals, Volume III: Pesticides. Lewis Publishers, Inc. Chelsea, MI. 684 pp.

3. Montgomery, J.H., and L.M. Welkom, 1989. Groundwater Chemicals Desk Reference, Volume I. Lewis Publishers, Inc. Chelsea, MI. 640 pp.

4. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.

5. Merck, 1989. The Merck Index, Eleventh Edition. Merck & Company, Inc. Rahway, NJ.

6. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.

7. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.

ENDRIN
ENDRIN KETONE
ENDRIN ALDEHYDE

GENERAL

Endrin is a pesticide that has been used to control insects and rodents. It is not currently produced or sold for general use in the United States. Endrin ketone is a breakdown product of endrin [1]. Little information pertaining to endrin ketone was located; therefore, all information in this profile applies specifically to endrin unless explicitly stated otherwise.

CAS NUMBERS

Endrin	72-20-8
Endrin ketone	53494-70-5
Endrin aldehyde	7421-93-4

COMMON SYNONYMS

Endrex, hexadrin, mendrin, nendrin [2,3,4]

ANALYTICAL CLASSIFICATION

Pesticide

PHYSICAL AND CHEMICAL DATA

Note: Data below for Endrin

Water Solubility: 0.25 mg/L at 25°C [1]
Vapor Pressure: 7.0×10^{-7} mm Hg [2]
Henry's Law Constant: 5.0×10^{-7} atm-m^3/mole [2]
Specific Gravity: 1.7 at 20/4°C [1]
Organic Carbon Partition Coefficient: 8,318 [2]

FATE DATA: HALF-LIVES

Soil: NR
Air: NR
Surface Water: NR
Groundwater: NR

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Insecticide; avicide; rodenticide [3,4].

FATE AND TRANSPORT

Endrin is a white, odorless, crystalline solid when pure, or a light-tan solid with a faint chemical odor when at technical- grade purity. It is soluble in acetone, benzene, carbon tetrachloride, hexane, xylene, aromatic hydrocarbons, esters, and ketones, but only marginally soluble in water. Releases of endrin to soils are highly resistant to degradation of any form. Endrin sorbs strongly to organic matter in soils and, therefore, can be expected to be highly immobile in soils. Endrin has, however, been detected in groundwater samples; this suggests that leaching may be possible under certain conditions. In addition, small amounts of endrin may volatilize to the atmosphere. The most prominent mechanism for transport to surface waters, other than direct discharge, is via sorption to particulate matter and subsequent soil erosion after rainfall or irrigation incidents. The primary removal/degradation mechanism in surface waters is photoisomerization of endrin to endrin ketone. Endrin will adsorb strongly to suspended solids/sediments in waters; this strong sorption will reduce the rate of volatilization from surface waters. Endrin resists biodegradation in soils and aerated waters; biodegradation may occur in flooded soils and anoxic waters (anaerobic conditions) at a somewhat enhanced rate. Products of microbial degradation include aldehydes and ketones, of which endrin ketone was the only metabolite identified. Typically, though, endrin will prove highly persistent in soils and waters. Given the high BCF of 15,136 for endrin, bioconcentration in aquatic organisms should be expected to be significant. Endrin found in the atmosphere is expected to exist primarily associated with particulate matter (via sorption), with small amounts found in the vapor phase. The primary removal/degradation mechanism for endrin in the atmosphere is predicted to be photoisomerization to endrin ketone. Additionally, reactions with hydroxyl radicals may be expected [2,4].

HUMAN TOXICITY

General. Endrin is a central nervous system depressant and hepatotoxin in humans. There is evidence that endrin may cause chromosomal damage [5]. The USEPA does not currently provide any toxicity values for endrin ketone or endrin aldehyde [5,6]. The USEPA has placed endrin in weight-of-evidence Group D, indicating that it is not classifiable as to carcinogenicity in humans [5].

Oral Exposure. A chronic RfD of 3×10^{-4} mg/kg/day is based on a NOEL of 0.025 mg/kg/day and a LOAEL of 0.05 mg/kg/day determined for histological lesions in the liver and occasional convulsions following dietary administration to dogs [5]. Human case studies have reported that endrin is absorbed following oral exposure. No quantitative data were available regarding absorption by humans or animals. The oral LD_{50} in male rats reportedly ranges from 28.8 to 43.4 mg/kg. while that for female rats ranges from 7.3 to 16.8 mg/kg. A number of human deaths have been linked to ingestion of endrin. In one case. flour containing 2,153 to 3.367 ppm was used to make bread. which was then consumed by up to 1.600 people. Twenty-six deaths occurred within 12 hours of the onset of symptoms [1]. A dose of 1 mg/kg may cause symptoms in humans [5]. Symptoms of oral exposure in humans and/or other mammals include central nervous system effects such as muscle contractions. hyperexcitability, and convulsions; degeneration of liver. kidney, and brain; and pulmonary edema. A single 1.5 mg/kg dose of endrin administered to pregnant hamsters had serious adverse effects on fetal development of the brain and spinal cord [1].

Inhalation Exposure. The USEPA does not currently provide an RfC for endrin [5.6]. Case reports of occupational exposure, as well as animal studies indicate that absorption takes place following inhalation exposure. However. no information was located on the rate and extent of such absorption. Six species of mammals were exposed to a concentration of 15 mg/m^3 for 7 hr/day. 5 days/week. for 130 exposures; 20% of the animals died. The dead animals were characterized by degenerative changes to the kidney, liver. and brain. Deaths in humans exposed occupationally have not been reported, although tonic-clonic contractions and seizures have been noted. Human and animal data suggest that death by inhalation is unlikely at typical concentrations encountered. Symptoms of exposure in humans are related to central nervous system effects. and include twitching and jerking of muscles. dizziness. mental confusion, and seizures [1].

Dermal Exposure. Endrin is rapidly absorbed through human skin. Symptoms appear between 20 minutes and 12 hours after exposure [5]. Rabbits exposed dermally experienced toxicity and death. indicating absorption. No quantitative data were available regarding absorption by humans or animals. A minimum lethal dose of 94 mg/kg and a NOAEL of 60 mg/kg was determined for rabbits by dermal exposure. Symptoms of intoxication following dermal application in rabbits include convulsions, tremors. twitching. salivation. lacrimation. shallow breathing, brain degeneration, fatty degeneration of the liver. and degenerative changes in the kidney [1].

ECOLOGICAL TOXICITY

General. Endrin was developed and widely used as an insecticide. As would be expected from this class of compounds, it has a high environmental toxicity for invertebrates and is also quite toxic to fish, birds, and mammals. It shows strong tendencies for bioaccumulation, with bioconcentration factors in aquatic systems on the order of 10^4 in invertebrates and fish. and 10^3 for algae (USEPA, 1979; [7.8].

Vegetation. Endrin is a very stable. chlorinated hydrocarbon insecticide with a soil half-life of 14 years or more [8]. It has a low water solubility and strongly adsorbs to the soil [8]. Therefore, endrin in soils would have a low bioavailability to plants.

Prager [7] included phytotoxicity information for terrestrial plants in a review article on endrin. Studies included in this review showed that endrin in the soil at concentrations of 1 to 30 ppm produced physiological effects in several crop species. At 100 ppm in soil, endrin significantly decreased the fresh weight of corn and bean plants. The growth rate of onion seedlings in soils containing approximately 1 ppm endrin was not affected. The use of 0.5 percent endrin as a coating for Douglas fir seeds had no significant effect on either germination or seedling growth. The use of 0.1 percent endrin to coat barley seeds had no effect on germination, but resulted in significantly reduced seedling height at 7 days and significantly higher pollen sterility in mature plants.

Toxicities of endrin to aquatic plants vary. Studies summarized by Prager [7] show inhibition of growth in freshwater algae at concentrations ranging from 0.475 mg/L to 20 mg/L. Endrin has been shown to bioaccumulate in freshwater algae, with bioconcentration factors ranging from 100 to 4,600 [7,8] No data were found on the toxicity of endrin to freshwater vascular plants or its bioaccumulation in these life forms..

Aquatic Life. The federal criterion for endrin for the chronic protection of freshwater aquatic life is 0.0023 μg/L [9]. The corresponding criterion from the State of Ohio for endrin in warmwater habitats is 0.002 μg/L [10].

These standards derive from the high toxicity of endrin to aquatic invertebrates and fish. For example, studies cited in several review articles [11,7,8] show 96-hour LC_{50}s (acute toxicities) for invertebrates range from 0.08 to 64 μg/L, with most values between 1 and 10 μg/L. Acute (96-hour) LC_{50}s for fish were between 0.1 μg/L and 4 μg/L, with most values less than 1 μg/L. Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [11].

A major concern for aquatic life is the bioconcentration of endrin. Studies have shown concentration factors ranging from 8,600 to 49,000 in snails, and from 7,000 to 15,000 in several species of freshwater fish [11,7,8]. However, endrin has been found to be eliminated quickly in aquatic vertebrates after termination of exposure. In studies cited by the USEPA [11], endrin levels in channel catfish and flagfish declined by 95 percent in 13 and 5 days, respectively, while tissue residues of 78 ppb in marine spot were reduced below detection levels in 13 days.

Wildlife. Toxicity of endrin to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents, dogs, and rabbits. Like other organochlorines, endrin tends to accumulate most heavily in adipose tissue [7]. However, as in aquatic vertebrates, nonlethal doses of endrin are rapidly excreted [7]. As a result, endrin does not bioconcentrate in the tissues of mammals as it does in lower animals. For example, dogs, cattle, and swine that were fed nonlethal doses of endrin from 4 weeks to 18 weeks had adipose tissue concentrations of endrin ranging from 0.25 to 8 times those in their diets [7]. However, these levels would be expected to decline rapidly. The biological tissue half-life of endrin in rats is 3 to 4 days, and in rabbits, more than 96 percent of radioactively labeled endrin was excreted in 49 days [7].

Birds are also susceptible to endrin poisoning. Studies summarize by Micromedex, Inc. [8] showed that mallards, ring-necked pheasant, bobwhite quail, and Japanese quail had 5-day LC_{50}s for ingestion of endrin ranging from 14 ppm to 22 ppm. However, as with mammals, bioaccumulation in bird tissues is limited by the ability of this biological class to excrete endrin. For example, after endrin was eliminated from their diets, mallard drakes with endrin tissue concentrations of 4.25 ppm eliminated 50 percent of the endrin in their tissues within 3 days, lost 50 percent of the remaining tissue endrin in the next 9 days, and had eliminated 90 percent of the original tissue burden of endrin in 33 days.

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Endrin/Endrin Aldehyde. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1990.
2. Montgomery, J.H., and L.M. Welkom, 1989. Groundwater Chemicals Desk Reference, Volume I. Lewis Publishers, Inc. Chelsea, MI. 640 pp.
3. Merck, 1989. The Merck Index, Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
4. Howard, P.H., 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume III: Pesticides. Lewis Publishers, Inc. Chelsea, MI. 684 pp.
5. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
7. Prager, J.C. (ed.), 1991. Chemical Review: Endrin. Dangerous Properties of Industrial Materials Report. Van Nostrand Reinhold, New York. Vol.11 (3): 202-234.
8. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.
9. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
10. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
11. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.

HEPTACHLOR
HEPTACHLOR EPOXIDE

GENERAL

Heptachlor is a man-made insecticide. It is a component of the pesticide chlordane. Heptachlor epoxide is a breakdown product of heptachlor.

CAS NUMBERS

Heptachlor	76-44-8
Heptachlor Epoxide	1024-57-3

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Pesticide (organic).

PHYSICAL AND CHEMICAL DATA

Characteristic	Heptachlor	Heptachlor Epoxide
Water Solubility at 25°C (mg/L) [1]:	0.18	0.200
Vapor Pressure at 25°C (mm Hg) [1]:	4×10^{-4}	1.95×10^{-5}
Henry's Law Constant at 25°C (atm-m^3/mole) [1]:	1.48×10^{-3}	3.2×10^{-5}
Specific Gravity at 9/4°C [2]:	1.57	ND
Organic Carbon Partition Coefficient [2]:	21.878	2.188 to 23.442

FATE DATA: HALF-LIVES

Medium	Heptachlor	Heptachlor Epoxide
Soil [3]:	23.1 hr to 5.4 da	33 da to 1.5 yr
Air [3]:	59 min to 9.8 hr	6 hr to 2.5 da
Surface Water [3]:	23.1 hr to 5.4 da	33 da to 1.5 yr
Groundwater [3]:	23.1 hr to 5.4 da	1 da to 3.0 yr

NATURAL SOURCES

None [2].

ARTIFICIAL SOURCES

Heptachlor was manufactured in the past for use as an insecticide. Since 1983 its use has been restricted to termite control. Chemical and biological transformation of heptachlor in the environment produces heptachlor epoxide. Heptachlor epoxide is not produced commercially, nor is it normally present in commercial heptachlor [1,2,4].

FATE AND TRANSPORT

Heptachlor strongly adsorbs to soils and should not leach extensively to groundwater. In soil, heptachlor will degrade to 1-hydroxychlordene and heptachlor epoxide, among other species. Volatilization from soil surfaces will be significant. Significant biodegradation occurs under both aerobic and anaerobic conditions. The volatilization half-life of heptachlor in aquatic media is estimated to range from 2 to 10 days. Heptachlor is expected to exist almost entirely in the vapor phase in ambient air. Reactions with photochemically-produced hydroxyl radicals and ozone in the atmosphere may be important fate processes. The physical removal of heptachlor from air by rainfall is of limited importance [1].

Heptachlor epoxide adsorbs strongly to soils and sediments/suspended solids in waters. On the soil surface, heptachlor epoxide may slowly photodegrade or volatilize, although it is expected to persist for many years. This compound is not expected to leach significantly to lower soil layers or to groundwaters. Little or no biodegradation, under aerobic or anaerobic conditions, is expected to occur in either soils or waters. In surface waters, photolysis may occur significantly in the presence of photosensitizers. Slow volatilization may occur as well, but is not considered a primary loss mechanism. Heptachlor epoxide, given its vapor pressure value, is expected to be found in the vapor phase, as well as adsorbing to particulate matter, in ambient air. Atmospheric loss mechanisms include vapor-phase reactions with hydroxyl radicals (considered an important process), gravitational setting of particulate matter, and atmospheric washout of heptachlor epoxide via rainfall. Wet deposition of heptachlor epoxide is considered to be the primary contamination mechanism of lakes. Atmospheric photolysis of heptachlor epoxide is expected to occur, as well as photolytic reactions occurring on plant surfaces (degradation products are ketones). This photolytic rate is affected by the form of solid material and the intensity of illumination. Finally, bioconcentration of this material in aquatic organisms is expected to occur readily [1].

HUMAN TOXICITY

General. Humans and animals may take in heptachlor epoxide directly, or they may produce it themselves following exposure to the insecticide heptachlor. Tremors and convulsions have been observed in humans and animals exposed to heptachlor. No reports of human fatalities were located [2]. The USEPA has placed both heptachlor and heptachlor epoxide in weight-of-evidence Group B2, indicating that they are probable human carcinogens [5].

Oral Exposure. A chronic RfD for heptachlor of 5×10^{-4} mg/kg/day is based on a NOEL of 0.15 mg/kg/day and an LEL of 0.25 mg/kg/day determined for increased liver weight in a chronic rat feeding study. A chronic RfD for heptachlor epoxide of 1.3×10^{-5} mg/kg/day is based on an LEL of 0.0125 mg/kg/day determined for increased liver-to-body weight ratio following subchronic administration to dogs [5]. Both heptachlor and heptachlor epoxide are absorbed after oral administration to rats. The acute oral LD_{50} values for heptachlor in rodents range from 40 to 162 mg/kg. The acute oral LD_{50} values for heptachlor epoxide in rats, mice, and rabbits range from 39 to 144 mg/kg. No information was available on human fatalities resulting from the ingestion of heptachlor or heptachlor epoxide. Cataracts and decreased postnatal survival were reported in the progeny of rats fed diets containing heptachlor [2]. An oral slope factor of 4.5 $(mg/kg/day)^{-1}$ is based on hepatocellular carcinomas observed in mice following dietary exposure to heptachlor. An oral slope factor of 9.1 $(mg/kg/day)^{-1}$ is based on hepatocellular carcinomas observed in mice following dietary exposure to heptachlor epoxide [5].

Inhalation Exposure. The USEPA does not currently provide RfC values for heptachlor or heptachlor epoxide [5,6]. Heptachlor epoxide is absorbed following inhalation. Heptachlor and heptachlor epoxide inhalation may cause blood dyscrasias [2,4]. An inhalation unit risk of 0.0013 $(mg/m^3)^{-1}$ for heptachlor is based on hepatocellular carcinomas observed in mice following dietary exposure. An inhalation unit risk of 0.0026 $(mg/m^3)^{-1}$ for heptachlor epoxide is also based on hepatocellular carcinomas observed in mice following dietary exposure [5].

Dermal Exposure. Heptachlor is readily absorbed through the skin. The dermal LD_{50} for heptachlor is 195 to 250 mg/kg/day in rats. No information specifically on heptachlor epoxide was located [2].

ECOLOGICAL TOXICITY

General. Heptachlor was developed and widely used as an insecticide for more than 20 years. Heptachlor expoxide is a degradation product of heptachlor. As would be expected, these compounds have a high environmental toxicity to invertebrates and are also quite toxic to fish, birds, and mammals. Heptachlor epoxide also shows strong tendencies for bioaccumulation, with bioconcentration factors on the order of 10^4 in algae, snails, and mosquito larvae and 10^3 for mosquito fish and spot [7].

Vegetation. Heptachlor that enters the soil system is strongly adsorbed to soil particles and resists both further volatilization and leaching into surface or ground waters. This characteristic limits the bioavailability of heptachlor in the soils to plants. In moist soils, heptachlor is decomposed primarily by hydrolysis, although biodegradation may also be significant. The half-life of heptachlor in soils is calculated to range from 04. to 0.8 years [8].

Heptachlor has been shown to inhibit the growth of simple plants like algae at concentrations of 26 to 2,260 µg/L [8]. No information was found concerning phytotoxic effects on higher plants. However, despite the widespread application of this compound for agricultural purposes, including seed treatment, there are few reported adverse effects on crop germination, growth, or yields. Therefore, it is assumed that heptachlor has low toxicity to vegetation.

As discussed previously, heptachlor epoxide is a decomposition product resulting from the hydrolysis of heptachlor. According to Micromedex, Inc. [8], heptachlor epoxide adsorbs strongly to soil and is extremely resistant to biodegradation, persisting for many years in the soil. Its strong bonds to soil also make it unavailable for plant uptake.

Heptachlor epoxide has a relatively low toxicity to plants, Lichtenstein et al. [9] grew corn, oats, peas, and cucumbers in quartz sand (which has minimal sorptivity) that had been treated with 30 ppm (30,000 µg/kg equivalent) of heptachlor epoxide. After 21 days, they found no significant differences in root or stem growth between the test plants and controls. Only oats had a significant decrease in respiration.

<u>Aquatic Life.</u> The federal aquatic life criteria for both heptachlor and heptachlor epoxide for the chronic protection of freshwater aquatic life are 0.0038 µg/L [10]. The corresponding criterion from the state for heptachlor is 0.001 µg/L [11]. Ohio does not have a state standard for heptachlor epoxide.

These standards derive from the high toxicity of heptachlor and heptachlor epoxide to aquatic invertebrates and fish. For example, studies cited in the USEPA "Red Book" [12] show 96-hour LC_{50}s (acute toxicities) for invertebrates of less than 1 µg/L and 96-hour LC_{50}s for fish usually between 1 µg/L and 10 µg/L. Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [12].

A major concern for aquatic life is the bioconcentration of heptachlor or its derivatives. Studies cited in the Red Book showed concentration factors ranging from 1,840 in bluegills to 21,300 in estuarine fish [12].

<u>Wildlife.</u> Toxicity of heptachlor and heptachlor epoxide to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents and rabbits. In the body, heptachlor is rapidly transformed into heptachlor epoxide, which accumulates chiefly in the adipose tissue, but which is also found in significant concentrations in the liver, brain, and muscle tissues [8].

The bioaccumulation and bioconcentration of heptachlor epoxide in the body is the primary concern. For example, two horses poisoned by heptachlor had bone marrow concentrations of heptachlor epoxide of 530 mg/kg of fat and 370 mg/kg of fat. Other tissue concentrations of heptachlor epoxide in these animals were as follows: renal fat - 550 mg/kg; brain - 49 mg/kg [8].

Birds are also susceptible to heptachlor poisoning. Studies summarized by Micromedex. Inc. [8] showed that mallards. ring-necked pheasant. bobwhite quail. and Japanese quail had 5-day LC_{50}s for ingestion of heptachlor ranging from 92 to 480 ppm. The Red Book cites data showing 100 percent mortality of woodcock with a dietary dosage of 0.72 ppm [12]. Bioaccumulation also occurs in birds, with a study cited by Micromedex. Inc. [8] showing that concentrations in the fat of broiler chickens plateaued at levels approximately five times those in their feed.

REFERENCES

1. Howard, P.H.. 1991. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. III: Pesticides. Lewis Publishers. Inc. Chelsea. MI. 684 pp.
2. ATSDR, 1991. Toxicological Profile for Heptachlor/Heptachlor Epoxide. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
3. Howard. P.H.; Boethling. R.S.; Jarvis. W.F.; Meylan. W.M.; and Michalenko. E.M.; 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Inc. Chelsea. MI. 725 pp.
4. Merck. 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway. NJ.
5. USEPA. 1995. Integrated Risk Information System (IRIS). On-line data base. March. 1995.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
7. USEPA. 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I: Introduction and Technical Background. Metals and Inorganics. Pesticides and PCB's. Office of Planning and Standards. Office of Water and Waste Management. Washington D.C. EPA-440/4-79-029a.
8. Micromedex. Inc.. 1992. Tomes Plus System. Toxicology. Occupational Medicine and Environmental Series. Volume 14. Denver. Colorado.
9. Lichtenstein. E.P.. W.F. Millington, and G.T. Cowlay. 1962.. Effect of various insecticides on growth and respirtion of plants. J. Agric. Food Chem. 24:560-563.
10. USEPA. 1991. Water Quality Criteria Summary. Washington. D.C.
11. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
12. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington. D.C.

LEAD

CAS NUMBER

7439-92-1

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not applicable [1]
Specific Gravity: 11.34 at 20/4°C [2]
Organic Carbon Partition Coefficient: ND [1]

FATE DATA: HALF-LIVES

Note: Data for tetraethyl lead; CAS No. 78-00-2

Soil: 1 to 4 weeks [3]
Air: 2.3 to 9.0 hours [3]
Surface Water: 2.3 to 9.0 hours [3]
Groundwater: 2 to 8 weeks [3]

BACKGROUND CONCENTRATIONS

Lead is a naturally-occurring element which is dispersed throughout the environment primarily as a result of anthropogenic activities [1]. The concentration of lead in minimally disturbed soils varies tremendously. A collection of 1,300 soil samples from across the conterminous U.S. determined that 80 percent were less than or equal to 30 ppm, with a geometric mean of 16 ppm, but with a maximum value as high as 700 ppm [4]. Concentrations along roadways and adjacent to houses with exterior lead-based paints may be as high as 10,000 ppm [1].

FATE AND TRANSPORT

Lead is extremely persistent in both water and soil. Environmental fate processes may transform one lead compound to another; however, lead itself is not degraded. It is largely associated with suspended solids and sediments in aquatic systems, and it occurs in relatively immobile forms in soil. Lead which has been released to soils may become airborne as a result of fugitive dust generation. Tetraethyl lead may occur in the vapor phase [1].

HUMAN TOXICITY

General. The general human population is exposed to lead primarily via the oral route of exposure, with some contribution from the inhalation route. However, in some subpopulations, the predominant route of exposure is via inhalation. The effects of lead are the same regardless of whether it enters the body through breathing or ingestion. The major health threat from lead arises from the damage it causes to the brain, especially in fetuses, infants, and young children. Young and developing humans are highly sensitive to its effects. Also, young children are prone to ingest more lead as a result of normal mouthing behavior. Decreased IQ and reduced growth may result from childhood exposure. Fetal exposure may result in preterm birth, reduced birth weight, and decreased IQ [1]. The Federal Centers for Disease Control recently lowered the threshold at which children are considered to have lead poisoning from 25 to 10 micrograms of lead per deciliter of blood [5]. Some of the health effects of lead, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood levels so low as to be essentially without a threshold [6].

Lead exposure may increase blood pressure in middle-aged men. High-level exposure can severely damage the brain and kidneys in adults or children. In addition, high doses of lead will cause abortion and damage the male reproductive system [1]. The USEPA currently does not provide any toxicity values for lead [6,7]. The USEPA has placed lead in weight-of-evidence Group B2, indicating that it is a probable human carcinogen [6].

Oral Exposure. Oral absorption of lead appears to be low in humans. The absorption of lead into the body is highly dependent on its state of complexation. In general, soluble lead compounds tend to be more readily absorbed into the body than insoluble compounds, and are therefore more toxic. Certain organic lead compounds are also readily absorbed. Gastrointestinal absorption is highly dependent on the form of lead and the amount of food present. For example, in one experiment 3 percent of lead chloride was absorbed when provided with a meal, but 60 percent was absorbed when animals were fasted. Lead absorption is higher in children than in adults. Oral LD_{50} values were not available. LD_{LO} values for various inorganic lead compounds reportedly ranged from 191 mg lead/kg in the dog to 20,500 mg lead/kg in the guinea pig. An LD_{LO} is the lowest dose causing death. The reported adverse effects of lead in laboratory animals following oral exposure include severe central nervous system damage, elevated blood pressure, impaired heme synthesis, liver damage, kidney damage, fetotoxicity, and damage to the reproductive organs in both males and females. Renal tumors have been observed in laboratory animals following oral administration of lead acetate [1].

Inhalation Exposure. Once deposited in the lower respiratory tract, lead is almost completely absorbed, and all chemical forms of lead also appear to be absorbed. Limited experimental evidence suggests that inhaled tetraethyl lead is rapidly absorbed by rats [1]. No other useful information was located regarding specific adverse health effects resulting from inhalation exposure to lead.

Dermal Exposure. Compounds such as lead acetate are poorly absorbed through skin, while tetraethyl lead appears to be rapidly absorbed [1]. No other useful information was located regarding specific adverse health effects resulting from dermal exposure to lead.

ECOLOGICAL TOXICITY

General. Lead is generally considered a highly toxic contaminant because it is not an essential nutrient to either plants or animals. Lead can be bioaccummulated, but it does not biomagnify in aquatic or terrestrial food chains. The tendency for lead to form complexes with naturally occurring organic material (e.g., humic and fulvic acids) increases its adsorption affinity for clays and other mineral surfaces, and decreases its bioavailability, except under acidic soil or water conditions. Benthic microbes can methylate lead to form tetramethyl lead, which is volatile and more toxic than inorganic lead [8].

Vegetation. Lead toxicity in plants under natural condition is uncommon even though field and laboratory studies have demonstrated lead's toxicity. Most of the lead in soils is insoluble and largely unavailable for plant uptake. Symptoms of lead toxicity are found only in plants grown on acid soils [9]. The amount of bioavailable lead taken up by plants decreases as soil pH, cation exchange capacity, and available phosphorus increase. Lead inhibits plant growth and reduces photosynthesis, mitosis, and water absorption. When taken up by plants, lead is rarely translocated because it becomes chelated in the roots [9]. Lead levels of approximately 500 mg/kg in soil reduced pollen germination by greater than 90 percent in two weed species. Normal germination rates were observed at soil levels of 46 mg/kg, but other adverse effects were observed at lead levels of 12 to 312 mg/kg [8].

Aquatic Life. The toxicity of lead in water is dependent on pH, organic materials, water hardness, and the presence of other metals [10]. Organolead compounds are more toxic than inorganic lead compounds to aquatic organisms [11]. Lead toxicity decreases with increasing water hardness [8]. Lead is more mobile in acidic waters than in higher pH waters. In alkaline and circumneutral waters, removal of lead by sorption and precipitation may occur relatively quickly [10]. The solubility of lead ranges from 500 μg/L in soft water to 3 μg/L in hard water [12]. In aquatic systems, most lead is found in bottom sediments. The toxicity of lead to fish varies from 0.1 to 542 mg/L. Generally, the medium tolerance limit for fathead minnows in hard water (360 mg/L $CaCO_3$) is 482 mg/L [12]. The federal chronic freshwater quality criterion for lead is 18.6 μg/L based on a water hardness of 400 mg/L $CaCO_3$ [13].

Wildlife. Lead bioaccumulates in animal tissues, but does not biomagnify in the food chain [10]. Evidence of lead poisoning in mammals and other wildlife have been reported from sites heavily contaminated by lead smelter emissions and other types of atmospheric fallout. Neurological effects in mallard ducks were observed within 24 hours of dosing them with lead shot for a total intake of 423.8 mg/kg body weight. Assuming a mallard weighs approximately 1.2 kg and consumes food equivalent to 10 percent of its body weight each day, dosage of 423.8 mg/kg body weight is equivalent to an approximate lead concentration in the food of 4,600 mg/kg [8]. It was found that 1,000 ppm dietary lead reduced egg production and caused soft-shelled eggs and 500 ppm inhibited growth and produced anemia [8].

REFERENCES

1. ATSDR, 1988. Toxicological Profile for Lead. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. February 1988.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. USGS, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
5. Hilts, P.J., 1991. "Lower Lead Limits Are Made Official." The New York Times. October 8, 1991.
6. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
7. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
8. CH2M Hill, Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver, Colorado.
9. USEPA, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
10. Golder Associates, Inc., 1991. Final Remedial Investigation for Mosley Road Sanitary Landfill, Denver, Colorado.

11. Eisler, R., 1988. Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews, Report 14, Biological Report 85(1.14). U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.
12. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
13. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.

NICKEL

CAS NUMBER

7440-02-0

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 8.90 [2]
Organic Carbon Partition Coefficient: NA [1]

BACKGROUND CONCENTRATIONS

Nickel is a naturally-occurring element. The concentration of nickel in minimally disturbed soils varies tremendously. A collection of 1,318 soil samples from across the conterminous U.S. determined that 81 percent were less than or equal to 20 ppm, with a geometric mean of 13 ppm, but with a maximum value as high as 700 ppm [3]. Nickel concentrations in Ohio farm soils were found to range from 9 to 38 ppm, with a mean value of 18 ppm [4]. Levels as high as 24,000 ppm have been found in soils near metal refineries [1].

FATE AND TRANSPORT

Nickel is dispersed throughout the atmosphere primarily as a result of anthropogenic activities. The primary source of nickel in the atmosphere is from the burning of fuel oil. Most of the nickel in the atmosphere occurs in the aerosol form, and is believed to be nickel sulfate. The average residence time for nickel in the atmosphere is 7 days, during which time long-distance transport may occur. Wet or dry deposition is expected to be the primary fate process in air [1].

Nickel is extremely persistent in water. Any nickel found in surface water or groundwater at moderate to high concentrations is probably of anthropogenic origin. In pristine environments, nickel tends to precipitate or be sorbed, leading to decreases in mobility and bioavailability. In polluted waters containing more organic matter, organic materials will keep nickel solubilized by complexation. In water under anaerobic conditions, and in the presence of sulfides, nickel will precipitate out as nickel sulfide. Nickel is not believed to volatilize from water, or undergo biotransformation by microorganisms in water. Nickel is bioaccumulated by some aquatic plants, but not fish [1].

The average residence time of nickel in soil is estimated to be 2,400 to 3,500 years. Although it is extremely persistent in soil, it can leach to groundwater. Organic complexing agents appear to restrict movement in soil. Nickel may be immobilized in soil as various inorganic complexes. It is not expected to volatilize from soil. It is reasonably mobile in low pH and cation exchange capacity mineral soils, but less mobile in basic mineral soils and soils with high organic content. Acid rain can facilitate leaching. Some terrestrial plants accumulate nickel [1].

HUMAN TOXICITY

General. The primary targets of nickel toxicity are the respiratory, gastrointestinal and immunological systems [1]. Studies in animals suggest that low levels of nickel may be necessary to maintain good health, but this has not been shown in humans [1]. Nickel is considered to be genotoxic. Metallic nickel has not been placed in a weight-of-evidence cancer group by the USEPA, but both nickel refinery dust and nickel subsulfide have been placed in Group A, indicating that they are human carcinogens [1].

Oral Exposure. A chronic oral RfD of 0.02 mg Ni/kg/day is based on a NOAEL of 5 mg Ni/kg/day for decreased body and organ weights in a chronic oral study in rats [5]. Nickel is poorly absorbed following oral exposure [1]. Acute oral LD_{50} values in rodents ranged from 66 to 136 mg Ni/kg [1]. A fatal oral dose in humans of approximately 570 mg Ni/kg has been reported [1]. Information regarding the effects of nickel in humans following oral exposure are limited. Gastrointestinal distress and effects on the blood were noted in workers who drank nickel-contaminated water from a drinking fountain (approximately 7 mg Ni/kg) [1]. Animal studies indicate that oral exposure to nickel (> 0.7 mg Ni/kg/day) can result in adverse effects on the blood, lungs, kidneys and sperm and decreases in body and organ weights [1]. There is no evidence that oral exposure to nickel causes developmental effects in humans, but animal studies suggest that nickel may be fetotoxic [1]. Oral exposure to metallic nickel has not been reported to cause cancer in humans or animals, therefore, an oral Slope Factor is not available [5].

Inhalation Exposure. An inhalation RfC for nickel is currently under review by the USEPA [5]. Approximately 35% of inhaled nickel is absorbed into the blood [1]. Acute inhalation exposure to nickel has not been reported to be fatal in humans, and acute LC_{50} values in animals are not available [1]. The respiratory system is the target of nickel toxicity in people employed in nickel refineries or in nickel processing plants.

Respiratory effects reported in occupationally exposed workers include chronic bronchitis, emphysema and reduced lung capacity. Of greater concern, however, is the production of cancer of the lung and nasal cavity. Recent studies indicate that cancer usually occurred when the workers were exposed to > 1 mg Ni/m^3 of soluble nickel compounds (such as nickel sulfate or nickel chloride) or to > 10 mg Ni/m^3 of insoluble nickel compounds (such as nickel oxide) [1]. An inhalation Unit Risk for cancer is not available for the soluble salts of nickel, but are available for nickel subsulfide and nickel refinery dust [5]. Inhaled nickel has not been associated with developmental or reproductive effects in humans, but testicular effects have been found in animal studies [1].

Dermal Exposure. Dermal exposure to nickel has not been reported to be fatal in humans or animals [1]. The most prevalent effect of nickel to the general population is the production of skin allergies that result in dermatitis [1]. These allergies can be elicited in sensitive individuals following exposure to nickel via any route [1].

REFERENCES

1. ATSDR. 1991. Toxicological Profile for Nickel (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
2. Merck. 1989. The Merck Index. Eleventh Edition. Merck & Company. Inc. Rahway. NJ.
3. USGS, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
4. Logan. T.J. and R.H. Miller. 1983. Background Levels of Heavy Metals in Ohio Farm Soils. Research Circular 275. Ohio State University. Ohio Research and Development Center. Wooster. Ohio. February 1983.
5. USEPA. 1995. Integrated Risk Information system (IRIS). Data base. Online. March. 1995.

MANGANESE

CAS NUMBER

7439-96-5

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: decomposes [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not Applicable [1]
Specific Gravity: 7.20 at 20/4°C [1]
Organic Carbon Partition Coefficient: Not Applicable [1]

BACKGROUND CONCENTRATIONS

Manganese is a naturally-occurring element. The concentration of manganese in minimally disturbed soils varies tremendously. A collection of 1.317 soil samples from across the conterminous U.S. determined that 89 percent were less than or equal to 700 ppm, with a geometric mean of 330 ppm. but with a maximum value as high as 7.000 ppm. Of fifteen samples collected around Ohio. 80 percent were found to contain manganese at concentrations less than or equal to 700 ppm, with a maximum value between 1.000 and 7.000 ppm [2].

FATE AND TRANSPORT

Environmental fate processes may transform one manganese compound to another; however, manganese itself is not degraded. Elemental manganese and inorganic manganese compounds may exist in air as suspended particulate matter. Such particles are removed from the atmosphere primarily by dry deposition, and, to a lesser extent, by washout. In water, the metal may exist in any of four oxidation states (2+, 3+, 4+, or 7+). Mn(+2) predominates in most waters, and usually combines with carbonate to form a compound of low solubility. In extremely reduced water, poorly soluble sulfides are formed. Manganese is often transported in rivers as suspended sediments. Manganese in water may be significantly bioconcentrated at lower trophic levels. Bioconcentration may not be significant in predatory fish: thus biomagnification may not be significant [1].

Adsorption of manganese to soils may be highly variable, increasing with higher organic content and anion-exchange capacity. At low concentrations, manganese may be "fixed" by clays, and will not be readily released into solution. At higher concentrations, it may be desorbed by ion exchange. For example, the discharge of waste water into estuarine environments resulted in the mobilization of manganese from the bottom sediments. Also, microorganisms may increase the mobility of manganese under some circumstances [1].

HUMAN TOXICITY

General. The only adverse health effect identified following exposure to high levels of manganese is a condition known as "manganism," which results in psychomotor disturbances. Manganese in small amounts is believed to be an essential nutrient for humans [1]. The USEPA has placed manganese in weight-of-evidence Group D; that is, it is not classifiable as to human carcinogenicity [3].

Oral Exposure. The chronic RfD for the manganese ranges from 0.005 mg/kg/day for the ingestion of manganese in water to 0.14 mg/kg/day for the ingestion of manganese in food [3]. Both RfDs are based on a NOAEL for central nervous system effects determined from human chronic ingestion data [3]. The amount of manganese absorbed from the gastrointestinal tract typically averages 3 to 5%. Most animal studies indicate that manganese compounds have low acute oral toxicity. A NOAEL of 2,300 mg/kg/day in food for 6 months was determined for mice. On the other hand, single doses of highly concentrated solutions of various manganese compounds delivered to rats by gavage produced LD_{50} values ranging from 410 to 820 mg manganese/kg/day. Thus it was concluded that high doses delivered by gavage did not yield a model relevant for normal environmental exposure. Evidence for the onset of manganism in humans following oral exposure is inconclusive. In animals, changes in the brain have been observed following very high oral exposure [1].

Inhalation Exposure. An RfC of 0.00005 mg/m^3 is based on a LOAEL of 0.15 mg/m^3 for impairment of neurobehavioral function in occupationally exposed workers [3]. The rate and extent of absorption of manganese following inhalation is unknown. A significant fraction of inhaled manganese-containing particles are carried via mucociliary transport to the gastrointestinal tract. Exposure of humans to high levels of manganese dust in air for a prolonged period of time (1 month to several years) may cause mental and emotional disturbances, and the impairment of locomotion and dexterity, a condition known as manganism. However, this condition has only been documented for workers in mines and foundries. Manganism occurs because excessive manganese injures a part of the brain that helps control body movements. Some of the symptoms of manganism can be reduced by medical treatment, but the brain injury is permanent [1].

Dermal Exposure. No information was located on the dermal absorption of manganese or adverse health effects resulting therefrom. It is reasonable to assume that intake via this pathway under normal circumstances is minimal.

ECOLOGICAL TOXICITY

General. Manganese is an essential trace element or micronutrient for plants and animals. Manganese does not occur naturally as a metal, but is found in various salts and minerals, frequently in association with iron compounds [4]. Manganese readily bioaccumulates in plants and animals, but does not biomagnify in food chains.

Vegetation. At pH values of 5.0 or less, manganese is rendered very soluble and excessive accumulation in plants can result. At pH values of 8.0 or above, precipitation results in the removal of bioavailable manganese from the soil [5].

Wetland plants, such as cattails, tend to maintain higher tissue concentrations of manganese than upland plants, probably because of greater availability of soluble manganese in wet soils or sediments [6]. Cattails can take up 779 mg/kg dry weight without injury [4]. Plants having more than 400 to 3,000 mg/kg of manganese (dry weight) in their tissues may exhibit toxic symptoms depending on the plant species [6]. Manganese toxicity in young plants is indicated by brown spotting on leaves [5]. Vegetation phytotoxic concentrations in soils and sediments are species specific and range widely.

Aquatic Life. Manganese ions are rarely found at concentrations above 1 mg/L, so manganese is not considered to be a problem in freshwater [7]. Manganese is toxic to fish in concentrations ranging from 1.5 to 1000 mg/L. Most toxic thresholds for fish are probably less than 50 mg/L [4]. Toxicity of manganese increases with decreasing pH [8]. Manganese has been shown to bioaccumulate in freshwater invertebrates [4]. There are no USEPA or OEPA aquatic life water quality standards [9,10].

Wildlife. The divalent form of manganese has a low order of toxicity to biota, especially to vertebrate animals. The hexavalent form is highly toxic, but does not occur in nature. Toxic concentrations of divalent manganese is reported in the diets of the following species: birds, 4,800 ppm; rats greater than 2,000 ppm; and rabbits 1,250 to 6,000 ppm. Toxic levels of manganese in mammals can cause decreased feed intake, decrease growth, reduced hemoglobin, and even death [11]. Growing rats have had dietary intake as high as 1,000 to 2,000 mg/kg with no apparent ill effects [6]. Maximum tolerable levels of manganese recommended by the National Academy of Sciences was 15 mg/kg body weight for sheep and cattle, 16 mg/kg body weight for swine, and 250 mg/kg body weight for poultry [11].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Manganese. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.
2. USGS, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
3. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
4. Snyder, B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
5. USEPA, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
6. Engineering-Science, Inc., 1991. Waste Site Investigation for Alcoa Massena Operation, Comprehensive Biota Sampling Program Report. Volume XII. Liverpool, N.Y.
7. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
8. Golder Associates, Inc., 1991. Final Remedial Investigation for Mosley Road Sanitary Landfill. Denver, Colorado.
9. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
10. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
11. CH2M Hill, Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver, Colorado.

4-METHYLPHENOL

CAS NUMBER

106-44-5

COMMON SYNONYMS

p-Cresol; 4-Cresol; 4-Hydroxytoluene; p-Methylphenol

ANALYTICAL CLASSIFICATION

Semi-Volatile

PHYSICAL AND CHEMICAL DATA

Water Solubility: 22.6 g/L at 40°C [1]
Vapor Pressure: 0.13 mm Hg at 25°C [1]
Henry's Law Constant: 9.6×10^{-7} atm-m^3/mole [1]
Specific Gravity: 1.0347 at 20/4°C [2]
Organic Carbon Partition Coefficient: 49 to 3420 [1]

FATE DATA: HALF-LIVES

Soil: 1 to 16 hours [3]
Air: 1.5 to 15 hours [3]
Surface Water: 1 to 16 hours [3]
Groundwater: 2 to 672 hours [3]

NATURAL SOURCES

Plant volatile. Methylphenols also occur in petroleum [1].

ARTIFICIAL SOURCES

When released into the environment, 4-methylphenol is most commonly associated with wastewater and emissions from its production in coal tar refining and its use as a disinfectant, as well as metal refining and chemical manufacturing. Emissions from autos and diesel engines, wood pulping, brewing, glass fibre manufacture, and tobacco smoke are sources of 4-methylphenol. The photooxidation of toluene will also produce 4-methylphenol [1].

FATE AND TRANSPORT

When released to water, biodegradation is expected to be the dominant loss mechanism. Volatilization of this chemical from water will be low. In soils, it is relatively mobile, and therefore can be expected to leach into groundwater. Biodegradation is rapid in soils, sewage, activated sludge, and freshwater inocula. In the atmosphere, it will react with hydroxyl radical during daylight hours and with nitrate radicals at night. Being a highly soluble chemical in water, it will be scavenged from the atmosphere by rain [1].

HUMAN TOXICITY

General. 4-Methylphenol is one of three methylphenol isomers (2-methylphenol, 3-methylphenol, 4-methylphenol) that are often found as a mixture. The major effects of 4-methylphenol are irritation of the skin, eyes, mouth and throat, and gastrointestinal distress (abdominal pain, vomiting) [4]. Information regarding the genotoxicity of 4-methylphenol are equivocal. 4-Methylphenol has been placed in weight-of-evidence Group C, indicating that it is a possible human carcinogen [5].

Oral Exposure. A chronic oral RfD of 0.005 mg/kg/day is based on a NOEL of 5 mg/kg/day for maternal death, respiratory distress, eye discharge, hypoactivity and cyanosis following exposure of rabbits during gestation [6]. 4-Methylphenol is readily absorbed following oral exposure. An acute oral LD_{50} value of 1800 mg/kg was reported for rats [4]. In humans, ingestion of a mixture of methylphenol isomers (in the form of Lysol cleaner) has been fatal with an estimated lethal dose of approximately 2000 mg/kg [4]. Symptoms of acute poisoning include throat and mouth burns, abdominal pain, vomiting, hematological effects (methemoglobin formation, intravascular hemolysis), renal toxicity and coma [4]. There is no information regarding effects in humans following long-term oral exposure to 4-methylphenol. Repeated oral exposure of animals to 4-methylphenol has resulted in decreased body weight gain and neurological effects (coma, tremors, convulsions) [4]. Information regarding the potential effects of ingested 4-methylphenol on human reproduction and development were not located, and animal studies suggest that 4-methylphenol is mildly fetotoxic, but only at doses that produce maternal toxicity [4]. There is no evidence that 4-methylphenol is carcinogenic in humans following oral exposure, but one animal study suggests 4-methylphenol may act as a promoter of forestomach carcinogenesis in hamsters [4]. An oral Slope Factor for cancer is not available for 4-methylphenol [5].

Inhalation Exposure. A chronic inhalation RfC for 4-methylphenol is considered non-verifiable by the USEPA [5]. 4-Methylphenol is absorbed following inhalation exposure, but the extent of absorption is not known. Inhaled 4-methylphenol has not been reported to be fatal to humans and acute inhalation LC_{50} values in animals are not available. Information regarding toxic effects of inhaled 4-methylphenol in humans are not available, but the isomer 2-methylphenol is a respiratory irritant in humans [4]. There is no information regarding effects on reproduction, development or cancer in humans or animals following inhalation exposure to 4-methylphenol. Consequently, an inhalation Unit Risk for cancer is not available for 4-methylphenol [5].

Dermal Exposure. An acute dermal LD_{50} value of 300 mg/kg is reported for rabbits [4]. Dermal exposure of humans to methylphenols has been reported to be fatal. In one of the fatal cases, the lethal dose was estimated at 820 mg/kg [4]. Methylphenols are strong skin irritants in both humans and animals with corrosive, irreversible damage being reported. Neurological effects, including coma, swelling of the brain and facial paralysis, have been reported following dermal exposure of humans to methylphenols. The exposure dose resulting in the effects is not known. 4-Methylphenol has not been evaluated for its ability to produce cancer following dermal exposure, but a cancer-promotion study indicates that all three methylphenol isomers may be tumor promoters [4].

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. I: Large Production and Priority Pollutants. Lewis Publishers, Inc. Chelsea, Michigan. 574 pp.
2. Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals, Second Edition. Van Nostrand Reinhold Company, Inc. New York, New York. 1310 pp.
3. Howard, P.H., R.S., Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. ATSDR, 1990. Toxicological Profile for Cresols: o-Cresol, p-Cresol, m-Cresol (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.
5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March, 1994.

MERCURY

CAS NUMBER

7439-97-6

COMMON SYNONYMS

Hydragyrum; quicksilver

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.56 mg/L [1]
Vapor Pressure: 2 x 10^{-3} mm Hg at 25°C [2]
Henry's Law Constant: ND
Specific Gravity: 13.534 at 25/4°C [2]
Organic Carbon Partition Coefficient: ND

BACKGROUND CONCENTRATIONS

Mercury is a naturally-occurring element. Elemental mercury is a silver-white, heavy, mobile, liquid metal exhibiting slight volatility at room temperature [2]. Concentrations of mercury at sampling points across the contiguous United States exhibit a limited, but varied range. A total of 1,267 soils samples were gathered by the United States Geological Survey for mercury concentration analysis. Of this total, 1,263 samples exhibited some concentration of mercury across a range of <0.01 ppm to a maximum of 4.6 ppm. Fourteen percent of the total samples gathered showed a mercury concentration of from less than 0.01 ppm up to 0.002 ppm; 16 percent showed concentrations between 0.002 ppm and 0.032 ppm, 33 percent between 0.032 and 0.051, 24 percent between 0.051 and 0.13, and 13 percent showed concentrations of mercury to be from 0.13 ppm up to a maximum value of 4.6 ppm; geometric mean concentration of mercury was 0.058 ppm. Fifteen soils samples were gathered in (or on a shared border of) Ohio. Of these samples, one showed a mercury concentration of between 0.02 and 0.032 ppm, two showed concentrations between 0.032 and 0.051, eight between 0.051 and 0.13, and four had mercury concentrations at values between 0.13 ppm up to 4.6 ppm (no data on Ohio maximum concentration) [3].

FATE AND TRANSPORT

Mercury may exist as one of three forms: elemental mercury, inorganic mercury, and organic mercury. Elemental mercury will combine with sulfur at ordinary temperatures, and react with nitric acid and/or ammonia solutions in air (to form Hg_2NOH); it does not react with hydrochloric acid, sulfuric acid (when cold), or alkalies. Mercurous salt will be slowly degraded by sunlight [2]. Inorganic mercury compounds generally dissociate into the mercuric form (Hg^{2+}) rather than the mercurous form (Hg^{-}). Organic mercury compounds are generally divided into two broad classes: alkyl mercury (e.g., monomethyl mercury) and phenyl mercury (e.g., phenylmercury acetate). Organic mercury compounds are more easily absorbed than elemental and/or inorganic forms, but will readily undergo biodegradation with the ultimate release of inorganic mercury. Organomercury compounds, especially alkyl mercury compounds, are viewed as posing the greatest toxicological danger [4]. Given their high specific gravity/density values, elemental and inorganic mercury compounds are generally susceptible to gravitational deposition in sediments of aqueous environments. Given the relative values of water solubility and vapor pressure, mercury should be expected to be a fairly mobile material. Mercury entering surface waters can be microbially converted to methylmercuric ion given favorable conditions. Methylmercury accumulates in carnivorous fish to levels 10,000 times those concentrations found in the ambient water [1].

HUMAN TOXICITY

General. Long-term exposure to either organic or inorganic mercury can permanently damage the brain, kidneys, and developing fetuses. Short-term exposure can also have adverse health effects, but full recovery is more likely. Methylmercury is a potent neurotoxin [1]. The USEPA has placed inorganic mercury in weight-of-evidence Group D, indicating that it is not classifiable as to human carcinogenicity [5].

Oral Exposure. The chronic RfD of 0.0003 mg/kg/day is based on kidney effects observed following oral administration in the rat [6]. Oral absorption of metallic mercury by humans has been estimated to be approximately 0.10%. Organic forms of mercury are readily absorbed by humans and animals via the oral route. For example, in one study approximately 95% of methylmercuric nitrate was absorbed. The oral LD_{50} for $HgCl_2$ ranged from 35 to 105 mg/kg in rats. The lethal dose of $HgCl_2$ in adult humans has been estimated to range from 10 to 42 mg/kg. Signs of acute mercury toxicity in humans and animals include gastrointestinal lesions and renal involvement. Death is usually caused by shock, cardiovascular collapse, acute renal failure, and severe gastrointestinal damage. A number of human deaths have resulted from organic mercury ingestion; the lethal dose is estimated to range between 10 and 60 mg/kg. A neurological syndrome in humans following the consumption of methylmercury-contaminated fish has been characterized by many symptoms including tingling in the extremities, impaired vision, hearing, taste, and smell, incoordination, weakness, slurred speech, irritability, memory loss, depression, and insomnia. Pregnant women who have ingested organic mercury have given birth to infants with severe brain damage. The evidence that the brain damage was caused by organic mercury is very strong [1].

Inhalation Exposure. The RfC of 0.0003 mg/m^3 is based on a NOAEL of 0.009 mg/m^3 determined for humans exposed by inhalation [6]. Metallic mercury diffuses rapidly across lung membranes into the blood. Studies have shown that about 74 to 80% of inhaled elemental mercury vapor is retained in human tissues. Exposure to a metallic mercury vapor concentration of 28.8 mg/m^3 for 1 to 30 hours reportedly caused death in rabbits. In humans, death reportedly occurred following exposure to about 1.1 mg/m^3 diethylmercury vapor for 4 to 5 months. Symptoms of exposure to metallic mercury vapor in humans include chest pains, dyspnea, cough, hemoptysis, impairment of pulmonary function, tremors, insomnia, decreased motor function, headaches, decreased libido, and irritability. Some kidney damage in humans may occur at vapor concentrations of elemental mercury of 0.1 mg/m^3. Inorganic mercury vapor has been reported to cause menstrual disturbances and spontaneous abortions in women, and congenital malformations and resorptions in the offspring of exposed female rats [1].

Dermal Exposure. Both inorganic and organic forms of mercury are absorbed by the skin, although the extent of absorption was not reported. Children exposed to inorganic mercury salts dermally, exhibited the following symptoms: tremor of face or extremities, sudden jerky movements, a lack of muscle tone, impaired reflexes, seizures, light sensitivity, deafness, insomnia, and irritability. Symptoms in an adult human exposed dermally to metallic mercury were reported to include headache, tinnitus, and vertigo [1].

ECOLOGICAL TOXICITY

General. Biologically, mercury is considered nonessential and nonbeneficial for plants and animals. It is a highly toxic element that can both bioaccumulate in biota and readily biomagnify through biological food chains, increasing by a factor of three to five at each higher trophic level [7]. Organic forms of mercury such as methylmercury and dimethylmercury are readily bioavailable; are produced by anaerobic bacteria in aquatic sediments; and are more toxic than inorganic mercury. Substantial environmental research has been conducted for this metal.

Vegetation. Mercury is not readily taken up by plants. Most higher vascular plants are resistant to mercury poisoning, although they may accumulate it to a limited degree [8]. Symptoms of toxicity include stunting of seedling growth and root development, and an inhibition of photosynthesis causing yield reduction [9]. Mercury concentrations in plant leaves range from 0.001 to 0.01 ppm [10]. The phytotoxic concentration of mercury in the soil was reported to be greater than 10 ppm [10]. Phytotoxic levels reported from four studies range from 0.3 to 5 mg/kg (soil dry weight) [9].

Aquatic Life. The most serious mercury contamination in the aquatic food chain occurs with methyl mercury. Methylmercury is very soluble in water, which means it is readily accumulated by aquatic organisms. Freshwater plants appear to be less sensitive than freshwater fish or invertebrates to methyl mercury. Bioaccumulation of mercury was markedly enhanced at elevated water temperatures, reduced water salinity or hardness, reduced water pH, increased age of the organism, and reduced organic matter content of the medium; in the presence of zinc, cadmium, or selenium in the solution; and after increased duration of exposure [11]. Mercury toxicity varies among species, with concentrations in water of 0.1 to 2.0 $\mu g/L$ fatal to sensitive aquatic species and concentrations of 0.03 to 0.1 $\mu g/L$ associated with significant sublethal effects [11]. Spawning in fathead minnows was inhibited by 0.00012 mg/L mercury, and the entire test population was killed by 0.0008 mg/L in 3 months [7]. Other studies with the same species, however, found only detrimental effects at 0.12 mg/L and no toxic effects at 0.07 mg/L [7]. Fish toxicity from mercury ranges from 30 $\mu g/L$ (guppy) to 1,000 $\mu g/L$ (*Mozambique tilapia*) [9]. In fish, the biological half-life of mercury is between 1 and 3 years [7]. Bioconcentration factors range from 5,000 for mercury to 4,000 to 85,000 for methylmercury [9]. For aquatic life protection, mercury water levels should not exceed 0.012 $\mu g/L$ (4-day average) or 2.4 $\mu g/L$ on an hourly average [11]. The federal chronic freshwater quality criterion for mercury is 0.012 $\mu g/L$ [12]. The Ohio chronic aquatic life habitat and water supply standard for mercury is 0.2 $\mu g/L$ for warmwater and modified warm water habitat [13].

Wildlife. Mercury in birds and mammals can adversely affect reproduction, growth and development, behavior, blood chemistry, coordination, vision, hearing, and metabolism [9]. Environmental concentrations of 0.1 ppm or greater would have significant detrimental effects on waterfowl population dynamics [7]. Intensive studies have been conducted on mallards. Studies of over three generations of mallards have shown that methylmercury fed in concentrations as low as 0.5 ppm resulted in reduced reproductive output and altered behavior in young ducklings. This concentration is calculated to be equivalent to 0.1 ppm in a wild diet [7]. Acute oral LD_{50} based on tests with five other bird species ranged from 2.2 to 37.8 mg/kg for methylmercury and 11.5 to 75.5 mg/kg for ethylmercury. The LD_{50} in mule deer for organomercury is 17.88 mg/kg [9]. Bowen [14] reported that a dietary intake of 800 ppm mercury (as HG^{+2}) was lethal to rats (study duration not provided). The biological half-life for mercury is 20 to 70 days in most species. The biological half-life of methylmercury in mammals is 70 to 80 days [7].

REFERENCES

1. ATSDR, 1989. Toxicological Profile for Mercury. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.

2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.

3. USGS, 1984. Elemental Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1720, U.S. Department of the Interior. United States Government Printing Office, Washington, D.C. 105 pp.

4. Ellenhorn. M.J.. and BarceCoux. D.G.. 1988. Medical Toxicology: Diagnosis and Treatment of Human Poisoning. Elsevier Science Publishing Company. Inc. New York. NY. 1512 pp.

5. USEPA. 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.

6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.

7. Snyder, B.D. and J.L. Snyder. 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.

8. Gough. L.P., H.T. Shaklette. and A.A. Case. 1979. Element Concentrations Toxic to Plants. Animals. and Man. U.S. Geological Survey Bulletin. No. 1466. Washington. D.C.

9. CH2M Hill. Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver, Colorado.

10. USEPA, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington. D.C.

11. Eisler. R.. 1987. Mercury Hazards to Fish. Wildlife. and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews. Report 10. Biological Report 85 (1.10). U.S. Department of the Interior. Fish and Wildlife Service, Washington. D.C.

12. USEPA. 1991. Water Quality Criteria Summary. Washington. D.C.

13. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code. Title 3745-Chapter 1. Ohio Environmental Protection Agency.

14. Bowen. H.J.M.. 1966. Trace Elements in Biochemistry. Academic Press. New York. 241 p.

NAPHTHALENE
2-METHYLNAPHTHALENE

GENERAL

There is relatively little information available on 2-methylnaphthalene as compared to naphthalene. Therefore, all information below refers to naphthalene unless explicitly stated otherwise.

CAS NUMBERS

Naphthalene	91-20-3
2-Methylnaphthalene	91-57-6

COMMON SYNONYMS

Naphthalene: Naphthene. Tar Camphor.
2-Methylnaphthalene: Beta-methylnaphthalene

ANALYTICAL CLASSIFICATION

Semi-Volatile Organic.

PHYSICAL AND CHEMICAL DATA

	Naphthalene	2-Methylnaphthalene
Water Solubility (mg/L at 20°C) [1]	31.7	ND
Vapor Pressure (mm Hg at 25°C) [1]	0.087	ND
Henry's Law Constant (atm-m^3/mole) [1]	4.6×10^{-4}	ND
Specific Gravity (20/4°C) [1]	1.145	1.0058
Organic Carbon Partition Coefficient [1]	933	ND

FATE DATA: HALF-LIVES (HRS)

Soil: 16.6 to 48 days [2]
Air: 2.96 to 29.6 hours [2]
Surface Water: 12 hours to 20 days [2]
Groundwater: 1 to 288 days [2]

NATURAL SOURCES

Crude oil; natural. uncontrolled combustion (i.e.. forest fires) [3.4].

ARTIFICIAL SOURCES

Naphthalene: Petroleum refining. mothball use and manufacture. coal tar distillation. pitch fumes, chemical intermediate (i.e.. phthalic anhydride manufacture). vehicle emissions. combustion processes (i.e.. refuse combustion). tobacco smoke. and oil spillage [3.4].

2-Methylnaphthalene: Synthesis of organic compounds such as insecticides, and release from gasoline due to its use as an additive [1,5].

FATE AND TRANSPORT

Naphthalene's sorption to soil ranges from low to moderate, depending upon the organic carbon content of the soil, and will leach rapidly through sandy soils. Volatilization from the uppermost soil layer will be important, but will lessen in importance with soil depth. In addition, volatilization from moisture-saturated soil is not expected to be important. Biodegradation is expected to be rapid in soils previously contacted with other polycyclic aromatic hydrocarbons (PAHs), but slow in "virgin" soils [3].

Volatilization, photolysis, sorption (to suspended solids, sediments, etc.), and biodegradation are the primary removal mechanisms for naphthalene in waters. The actual predominant mechanisms change with variations in several factors (i.e., water flow rate, level of sediments/suspended soils, water clarity, etc.) In addition, biodegradation rates of naphthalene in water vary with changes in concentration of naphthalene (higher concentrations yield higher rates), "virgin" versus oil-polluted water (quicker in oil-polluted waters), actual pollution site (more rapid biodegradation in sediments than waters), aerobic versus anaerobic conditions (no biodegradation in anaerobic conditions), and so on. Bioconcentration in aquatic organisms is expected to be moderate, except for accelerated bioconcentration in organisms lacking an aryl hydroxylase enzyme system (i.e. phytoplankton, snails, mussels). Naphthalene in the atmosphere reacts during daylight hours with hydroxyl radicals, and during nighttime hours with nitrate radicals. Photolysis is also expected in the atmosphere [3].

HUMAN TOXICITY

General. The breakdown of red blood cells is the primary health concern for humans exposed to naphthalene. Human deaths following ingestion have occurred [1]. The USEPA has placed naphthalene in weight-of-evidence Group D, indicating that it is not classifiable as to human carcinogenicity [6]. The USEPA does not currently provide any toxicity values for 2-methylnaphthalene [6,7].

Oral Exposure. Both the chronic and subchronic RfDs for naphthalene of 0.04 mg/kg/day are based on a NOEL of 50 mg/kg/day for decreased body weight observed in a subchronic oral (gavage) study in rats [7]. Clinical evidence indicates that naphthalene is absorbed by humans in significant quantities via the oral route. The oral LD_{50} reported for naphthalene in rats ranges from 2,200 to 2,400 mg/kg in rats [1]. The oral LD_{50} reported for 2-methylnaphthalene in rats is 1,630 mg/kg [5]. Lethal doses of naphthalene in humans have ranged from as low as 74 mg/kg to as high as 574 mg/kg [1]. Ocular damage has been documented in humans and animals following oral exposure [1]. Symptoms of intoxication include: nausea, vomiting, headache, diaphoresis, hematuria, hemolytic anemia, fever, central nervous system depression, hepatic necrosis, jaundice, convulsions, and coma [1,2,8].

Administration of 300 mg/kg/day to pregnant mice resulted in a decrease in the number of live pups per litter [1].

Inhalation Exposure. An inhalation RfC was not reported for naphthalene [6,7]. Clinical reports suggest that inhaled naphthalene may be absorbed in sufficient quantity to produce adverse health effects in humans; however, no quantitative absorption data were located for humans or animals. One study, on rats, reported a NOAEL of 78 ppm for a 4-hour exposure. Symptoms and effects of inhalation exposure in humans include: headache, nausea, vomiting, abdominal pain, malaise, confusion, anemia, jaundice, and renal disease. No information was found regarding developmental and reproductive effects [1].

Dermal Exposure. Limited evidence in human infants indicated that hemolytic anemia may have resulted from dermal exposure to an unknown quantity of naphthalene. A NOAEL of 2,500 mg/kg was reported for rats. Naphthalene is a mild dermal and ocular irritant [1].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Naphthalene and 2-Methylnaphthalene. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1990.
2. Howard, P.H.; Boethling, R.S.; Jarvis, W.F.; Meylan, W.M.; and Michalenko, E.M.; 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.
3. Howard, P.H., 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Vol. I: Large Production and Priority Pollutants. Lewis Publishers, Inc. Chelsea, MI. 574 pp.
4. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
5. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide. Volume 4. Cambridge, MA. July 1989.
6. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
7. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1995. (Information received via contact with the Superfund Technical Support Center).
8. National Institute for Occupation Safety and Health, 1991. Registry of Toxic Effects of Chemical Substances (RTECS), Volume I-III. United States Department of Health and Human Services. Cincinnati, OH.

PHENOL

CAS NUMBER

108-95-2

COMMON SYNONYMS

Hydroxybenzene

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 87,000 mg/L at 25°C [1]
Vapor Pressure: 0.524 mm Hg at 25°C [1]
Henry's Law Constant: 3.97×10^{-7} atm-m^3/mole [1]
Specific Gravity: 1.07 at 20/20°C [2]
Organic Carbon Partition Coefficient: 148 [1]

FATE DATA: HALF-LIVES

Soil: 1 to 10 days [3]
Air: 2.28 to 22.8 hours [3]
Surface Water: 0.22 to 2.4 days [3]
Groundwater: 0.5 to 7 days [3]

NATURAL SOURCES

Animal wastes, decomposition of organic wastes. [1]

ARTIFICIAL SOURCES

Wastewater; resins, plastics, fibers, adhesives, iron and steel; aluminum, leather, and rubber industries; spills connected with its transport and use. Phenol is also found in cigarette smoke, and automobile exhaust, as well as disinfectants and medicinal products. [1]

FATE AND TRANSPORT

Phenol will rapidly degrade in sewage, soil, freshwater, and seawater. When it is released to soil, biodegradation will occur in under five days. Groundwater can be expected to be free of this chemical due to the rapidity of degradation. In freshwater systems, it can be expected to biodegrade on the order of hours to days, and in estuarine waters up to a few weeks. It will exist in the vapor phase in the atmosphere. Evaporation is not a primary loss mechanism.

Generally, biodegradation will be quicker under aerobic conditions for both soils and water. Bioconcentration is not significant [1].

HUMAN TOXICITY

General. Phenol is considered to be very toxic. Human deaths due to phenol exposure have been reported [2,4]. Based on animal studies, exposure to high levels of phenol vapor for several weeks results in paralysis and severe injury to the heart, kidneys, liver, and lungs [2]. The USEPA has placed phenol in weight-of-evidence Group D, indicating that it is not classifiable as to human carcinogenicity [4].

Oral Exposure. A chronic RfD of 0.6 mg/kg/day is based on a NOAEL of 60 mg/kg/day and a LOAEL of 120 mg/kg/day determined for reduced fetal body weight in a rat oral developmental study [4]. Phenol is readily absorbed via the gastrointestinal tract in humans and animals. Up to 98% of an orally-administered dose was absorbed by humans, while up to 95% was absorbed by rats. The oral LD_{50} for rats varies depending on the concentration of dosing solution used, but ranges from 340 to 530 mg/kg. Acute oral poisoning in rats and rabbits is characterized by muscular tremors in the head region, followed by effects in the lower extremities [2]. The probable lethal oral dose in humans is 50 to 500 mg/kg, and ingestion of 1 gram has been lethal. Symptoms of exposure in humans include sonorous breathing, frothing at the mouth and nose [4], mouth sores, and diarrhea [2].

Inhalation Exposure. An inhalation RfC for phenol is considered non-verifiable by the USEPA [4]. Phenol is readily absorbed following inhalation exposure. Up to 99% absorption was determined for humans. A concentration of 26 to 52 ppm phenol was lethal to guinea pigs over the course of a 28-day exposure. The effects on the lungs in these guinea pigs included inflammation, cellular infiltration, pneumonia, and bronchitis. Phenol exposure in animals has also been shown to cause severe damage to the heart, liver, and kidney. A concentration of 26 ppm was reported as the LOAEL for serious neurological effects in guinea pigs exposed for 41 days. No useful information was found regarding adverse effects of phenol inhalation in humans [2].

Dermal Exposure. Phenol is readily absorbed from skin. Substantial dermal absorption of phenol vapor occurs. The dermal LD_{50} for molten phenol liquid in the rat was reported to be about 669 mg/kg, while application of a 66% aqueous solution (330 mg phenol/kg) was 100% lethal to rats. Application of concentrated phenol to skin results in severe edema, erythema, and necrosis. Muscle tremors and convulsions are a characteristic response of laboratory animals to acute dermal phenol toxicity [2]. Skin exposure in humans may cause pain followed by numbness [4]. Arrhythmias have been associated with dermal exposure of humans. Human deaths have occurred following dermal exposure to phenol. Phenol applied to the skin is reportedly a tumor promoter and possibly a complete carcinogen in mice [2].

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals. Vol. I: Large Production and Priority Pollutants. Lewis Publishers. Inc. Chelsea. Michigan. 574 pp.
2. ATSDR, 1989. Toxicological Profile for Phenol. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko. 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea. Michigan.
4. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.

PENTACHLOROPHENOL

CAS NUMBER

87-86-5

COMMON SYNONYMS

PCP; Penchlorol

ANALYTICAL CLASSIFICATION

Pesticide (organic).

PHYSICAL AND CHEMICAL DATA

Water Solubility: 14 mg/L at 20°C [1]
Vapor Pressure: 1.10 x 10^{-4} mm Hg at 25°C [1]
Henry's Law Constant: 2.75 x 10^{-6} atm-m^3/mole [1]
Specific Gravity: 1.978 at 22/4°C [2]
Organic Carbon Partition Coefficient: 1000 - 4000 [1]

FATE DATA: HALF-LIVES

Soil: 23 - 178 days [3]
Air: 5.8 - 58 days [3]
Surface Water: 1 hour - 4.6 days [3]
Groundwater: 46 days - 4.2 years [3]

NATURAL SOURCES

Fungus metabolism [1].

ARTIFICIAL SOURCES

Wood preservative; fungicide; bactericide; algicide; herbicide [1].

FATE AND TRANSPORT

Given its high K_{oc} value, pentachlorophenol will adsorb to soils, with stronger adsorption occurring under acid conditions. In soils, slow biodegradation and leaching into groundwater will occur. Biodegredation of pentachlorophenol appears to become significant after a period of acclimation. In soils, biodegredation appears more thorough under anaerobic conditions, yielding byproducts such as pentachloroamisole and tri-/tetrachlorophenols (as well as 2,3,7,8-tetrachlorophenol and carbon dioxide, in estuarine sediment). Photolysis does not readily occur in soils. but will occur with dissociated pentachlorophenol (which occurs at ambient pH levels) to a significant degree. Given the tendency of pentachlorophenol to dissociate in acidic soils, leaching to unprotected groundwater is possible. Hydrolysis and oxidation do not appear to be significant loss mechanisms in either soils or waters. Volatilization from soils and water may occur, but is not predicted to be significant. Bioconcentration of this material in aquatic organisms is expected, but is dependant upon pH levels of the aquatic environment (since pentachlorophenol will be dissociated at higher pH levels) [1].

Atmospheric pentachlorophenol may be found in the vapor phase or adsorbed to particulate matter. Vapor-phase pentachlorophenol undergoes photolysis and, to a lesser extent, hydroxyl-radical reaction. Particulate adsorbed complexes are subject to gravitational deposition [1].

HUMAN TOXICITY

General. The major targets of pentachlorophenol toxicity are the liver and kidneys [4]. Information regarding the genotoxicity of pentachlorophenol are equivocal [4]. The USEPA has placed pentachlorophenol in weight-of-evidence cancer Group B2, indicating that it is a probable human carcinogen [5].

Oral Exposure. The chronic oral RfD of 0.03 mg/kg/day is based on a NOAEL of 3 mg/kg/day for liver and kidney effects in a chronic study in rats [5]. Pentachlorophenol is readily absorbed following oral exposure. Acute oral LD_{50} values in animals ranged from 27 to 230 mg/kg in rats and 117 to 134 mg/kg in mice [4]. The lowest lethal dose of pentachlorophenol in humans is estimated at 1 gram (14 mg/kg) [4]. Limited data in humans indicate that pentachlorophenol is a neurotoxin. Neurological effects result from the ability of pentachlorophenol to disrupt biochemical pathways, and not from direct effects on the nervous system [4]. Studies in animals indicate that oral exposure results in effects on the liver, kidneys and blood at doses greater than 2.5 mg/kg/day [4]. Data in animals suggest that pentachlorophenol is not teratogenic (causing birth defects), but may be toxic to both the fetus and the mother [4]. There is no evidence that pentachlorophenol causes cancer in humans, but studies in animals suggest that oral exposure results in cancer of the liver and blood vessels [4]. An oral slope factor of 0.12 $(mg/kg/day)^{-1}$ is based on the incidence of cancer of the liver and blood vessels in rodents [5].

Inhalation Exposure. A chronic inhalation RfC for pentachlorophenol is currently under review by the USEPA [5]. Inhalation LC_{50} values in rats ranged from 1.2 ppm (45 minutes) to 31 ppm (exposure time not specified) [4]. Based on animal studies, NIOSH determined that a concentration of 14 ppm is immediately dangerous to human life and health [4]. Inhalation of 0.09 ppm has resulted in irritation to the eyes and nose [4]. Inhaled pentachlorophenol has not been shown to cause effects on reproduction or development or to cause cancer in humans or animals [4]. An inhalation unit risk for cancer is not available for pentachlorophenol [5].

Dermal Exposure. Exposure in the workplace or misuse of pentachlorophenol-containing products in the home are the most likely methods of exposure. The primary route of exposure in these cases is dermal, although inhalation probably also occurs. Effects on the respiratory tract (congestion, edema), blood (anemia), liver (enlarged liver, degeneration), kidneys (dysfunction), and skin (skin eruptions) have been reported following occupational exposure, but the exposure concentration is not known [4]. Neurological effects have also been observed, but these effects probably result from the ability of pentachlorophenol to disrupt biochemical pathways, and not from direct effects on the nervous system [4].

ECOLOGICAL TOXICITY

General. Pentachlorophenol and its sodium salt (sodium pentachlorophenate) are among the mostly widely used pesticides and wood preservative in the United States. Both compounds have the same toxic effects, but different solubilities [6]. Pentachlorophenol will bioconcentrate because of its low water solubility, but the BCF will be dependent upon the pH [7]. With water pH of 7.3, the photodegradation of ionized pentachlorophenol was completed in 20 hours [6]. No information on biomagnification was available in the technical literature.

Vegetation. Pentachlorophenol is strongly phytotoxic [6]. It has a tendency to adsorb to soil and sediment. Adsorption to soil and sediment appears to be pH dependent, and is stronger under acid conditions [8]. According to Eisler [9], terrestrial plants were adversely affected by pentachlorophenol at 0.3 mg/L. Micromedex, Inc. [8] gives its toxicity to aquatic plants at 0.001 ppm.

Aquatic Life. Increasing pH of the water column decreases the hazard of pentachlorophenol to aquatic biota. Pentachlorophenol is rapidly accumulated and rapidly excreted, and has little tendency to persist in living organisms. It also is readily degraded in the environment by chemical, microbiological, and photochemical processes [9]. Adverse effects on growth, survival, and reproduction of sensitive species of aquatic organisms occurred at concentrations of 8 to 80 μg/L for algae and macrophytes, 3 to 100 μg/L for invertebrates, and <1 to 68 μg/L for fish [9]. The accumulation of pentachlorophenol in fish is rapid and primarily by direct uptake from water rather than through the food chain or diet. Fish can bioconcentrate pentachlorophenol from water up to 10,000 times [9], but the half-life in fish tissues is less than 24 hours. The mean acute LC_{50}s values are 63.1 μg/L for fathead minnow and 65.5 μg/L for goldfish. The mean value is derived because the toxicity of pentachlorophenol varies with pH [10]. Micromedex, Inc. [8] reported a 96-hour LC_{50} for bluegill at 32 μg/L. Eisler [9] proposed pentachlorophenol criteria for protection of aquatic biota. For freshwater life, the acute criterion was 48 to <55 μg/L, and the chronic criterion was <3.2 μg/L. For warmwater fish, the criterion was 10 to <15 μg/L. The USEPA acute and chronic aquatic life water quality criteria for pentachlorophenol are 20 μg/L and 13 μg/L, respectively, based on a pH of 7.8 [11]. The OEPA water quality standards for aquatic life are also pH dependent. The criteria for pentachlorophenol are based on warmwater and modified warmwater habitats and are listed as: 5.2 μg/L for pH 7.0, 8.6 μg/L for pH 7.5, and 14.0 μg/L for pH 8.0 [12].

Wildlife. Eisler [9] reported pentachlorophenol killed various species of birds at single oral doses of 380 to 504 mg/kg body weight, at dietary concentrations of 3,850 mg/kg ration fed over a 5-day period, and when nesting materials contained >285 mg/kg. The acute oral LD_{50} for mallards is 380 mg/kg body weight, for rabbits 100 to 130 mg/kg body weight, and for mice is 65 to 252 mg/kg body weight [9]). Sax [13] gives the oral LD_{50} for rats at 50 mg/kg and hamsters at 168 mg/kg. Eisler [9] proposed pentachlorophenol criteria for the protection of wildlife. For bird diets, the recommended criteria were <1.0 mg/kg to avoid adverse effects and >3,850 mg/kg for fatal effects. In a study on rats, 3 to 10 mg/kg body weight produced no adverse effects [9].

REFERENCES

1. Howard, P.H., 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Vol. III: Pesticides. Lewis Publishers, Inc. Chelsea, MI. 684 pp.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.
4. ATSDR, 1989. Toxicological Profile for Pentachlorophenol. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
6. Williams, Phillip L., 1988. Pentachlorophenol. Dangerous Properties of Industrial Materials Report. Vol. 8(1):2-7.
7. Golder Associates, Inc., 1991. Final Remedial Investigation for Mosley Road Sanitary Landfill. Denver, Colorado.
8. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.
9. Eisler, R., 1989. Pentachlorophenol Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Review, Report 17, Biological Report 85(1.17). U.S. Department of Interior, Fish and Wildlife Service. Washington, D.C.
10. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Vol. II. Office of Water and Waste Management, Washington, D.C. EPA-440/4-79-029.
11. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.

12. OEPA, 1991. Ohio Water Quality Standards. Administrative Code. Title 3745-Chapter 1. Ohio Environmental Protection Agency.

13. Sax, N.I., 1984. Dangerous Properties of Industrial Materials. 6th ed. Van Nostrand Reinhold. New York.

POLYCHLORINATED BIPHENYLS
(PCBs)

GENERAL

Polychlorinated biphenyls (PCBs) represent a class of chlorinated aromatic compounds which, until they were banned in 1979, had widespread industrial application because of their stability, inertness, excellent dielectric properties, and excellent solvent characteristics [1]. There are 209 possible PCB congeners when biphenyl is chlorinated. Monsanto Corporation marketed mixtures of PCBs under the trade name Aroclor. The Aroclors are identified by a four-digit numbering code in which the first two digits indicate biphenyl (12 carbon atoms), and the last two digits indicate the average chlorine content by weight percent. For example, Aroclor 1260 has an average chlorine content of 60%. An exception to this system is Aroclor 1016, with an average chlorine content of 41% [2]. Given their extensive past usage history, PCBs may be expected to be found throughout the environment. This profile addresses four Aroclors and PCBs collectively, as listed below.

CAS NUMBERS

Aroclor 1242	53469-21-9
Aroclor 1248	12672-29-6
Aroclor 1254	11097-69-1
Aroclor 1260	11096-82-5
Aroclor 1016	12674-11-2
PCBs	1336-36-3

COMMON SYNONYMS

PCBs, Aroclors

ANALYTICAL CLASSIFICATION

Semivolatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 6.00×10^{-3} to 2.40×10^{-1} mg/L at 24 to 25°C [3]
Vapor Pressure: 7.71×10^{-5} to 4.06×10^{-4} mm Hg at 25°C [3]
Henry's Law Constant: 5.60×10^{-4} to 2.70×10^{-3} atm-m^3/mole [3]
Specific Gravity: 1.38 to 1.62 at 25°C [2]
Organic Carbon Partition Coefficient: 5.13×10^3 to 2.63×10^6 [3]

FATE DATA: HALF-LIVES

Soil: 6 to > 365 days [1]
Air: 2 days to 4.7 years [1]
Surface Water: 9.5 hours to > 365 days [1]
Groundwater: persistent

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Electrical transformers; dielectric fluids; solvents.

FATE AND TRANSPORT

As a class of compounds, polychlorinated biphenyls exhibit a tendency to sorb strongly to soils and suspended solids/sediments in waters. PCB releases to the environment, then, will be expected to show very limited mobility and present only a slight danger of leaching to unprotected groundwaters. There is a wide distribution of a variety of microorganisms capable of degrading PCBs, mainly through dechlorination actions. The degradation rate/action of these microorganisms is lowered, however, as the number of chlorine ion substitutions on the biphenyl parent compound increases. In addition, biodegradation rates are slowed by the tight sorptive ability of PCBs, low ambient temperatures, low moisture content, extremes in pH, and available oxygen content (with no biodegradation evidenced under anaerobic conditions). The number of chlorine ion substitutions also affects volatilization and photoionization rates; as chlorine ion substitutions increase, so do these rates. PCBs volatilized to the atmosphere undergo two major modes of degradation: reaction with hydroxyl radicals and/or reaction with ozone. Reaction with hydroxyl radicals (resulting in substitution of OH^- for Cl^- on the biphenyl parent compounds) is the more important of these two processes. Hydrolysis and/or oxidative reactions are not considered to be important fate processes for PCBs. Generally, PCBs having a higher chlorine content exhibit greater persistency in the environment than do PCBs with lower chlorine content. Bioconcentration of PCBs in aquatic organisms is expected to be an important process for all PCBs, and shows an increase as the chlorine content increases [1].

HUMAN TOXICITY

General. PCBs are known to cause skin irritations, such as acne and rashes, in humans. Young children of women who ate foods containing high levels of PCBs, such as fish, before and during their pregnancies may experience learning difficulties. Consumption of contaminated food is presumed to be the major route of exposure for the general population [2]. The USEPA has placed PCBs in weight-of-evidence Group B2, indicating that they are probable human carcinogens [4].

Oral Exposure. A chronic RfD of 0.00007 mg/kg/day for Aroclor-1016 is based on a NOAEL of 0.007 mg/kg/day for reduced birth rates in chronically exposed monkeys [4]. A chronic RfD of 0.00002 mg/kg/day for Aroclor-1254 is based on a LOAEL of 0.005 mg/kg/day for clinical effects (ocular exudate, inflammed and prominent Meibomian glands, distorted growth of finger and toe nails) and immunological effects (decreased antibody response to sheep erythrocytes) in a chronic study in monkeys [4]. PCBs are readily absorbed by humans via the oral route. Absorption in rats reportedly ranges from 75% to 90% of the administered dose. Single-dose LD_{50} values determined for rats ranged from 1,010 mg/kg for Aroclor 1254 to 4,250 mg/kg for Aroclor 1242 [2].

Numerous studies have been done on human children born to mothers who consumed large quantities of PCB-contaminated fish while pregnant. In one such study, the concentrations in the fish consumed ranged from 168 ppb to 3,012 ppb. Overall consumption of fish and levels of total PCBs in cord serum were positively correlated with lower birth weight, smaller head circumference, and shorter gestational age. By 7 months of age the infants with the highest levels of PCBs in cord serum scored significantly lower on neurobehavioral tests. By 4 years of age the children with the highest levels of PCBs in cord serum exhibited poorer performance on tests involving short-term memory [2].

Occupational studies have indicated possible PCB-related cancers of the liver, gastrointestinal tract, hematopoietic system, and skin [2]. An oral slope factor of 7.7 $(mg/kg/day)^{-1}$ is based on hepatocellular carcinomas observed in rodents [4].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for PCBs [4,5]. Qualitative evidence exists that PCBs are absorbed via inhalation in humans and rats. NOAELs in rats, rabbits, guinea pigs, and mice exposed for up to 121 days ranged from 5.4 to 8.6 mg/m^3. A LOAEL of 1.5 mg/m^3 for liver and kidney degeneration was determined for rats exposed for 213 days. Upper respiratory tract and eye irritation, cough, and tightness of the chest were symptoms noted in humans exposed to 0.007 to 11 mg/m^3. Low birth weight and shortened gestational age has been correlated with occupational exposure of pregnant women to PCBs; however, confounding factors make these studies suspect [2]. The USEPA does not currently provide an inhalation slope factor or unit risk for PCBs [4,5].

Dermal Exposure. Hard data on dermal absorption of PCBs by humans and animals are lacking. Absorption efficiency in rhesus monkeys and guinea pigs ranged from about 15% to 34%. Median lethal doses for single dermal applications of PCBs to rabbits were as follows (mg/kg): <1,269 for Aroclors 1242 and 1248, <3,169 for Aroclors 1221 and 1262, and <2,000 for Aroclors 1232 and 1260. Liver and kidney damage were noted in rabbits treated dermally 5 days/week for up to 38 days with up to 44 mg/kg/day Aroclor 1260 [2].

ECOLOGICAL TOXICITY

General. This discussion is limited to Aroclors 1254 and 1260. Environmental persistence of PCBs is determined by the degree of chlorination. Higher chlorobiphenyls, i.e., those with five or more chlorine atoms, are more persistent in the environment than those with three or fewer chlorine atoms. Aroclor 1254 has five chlorine atoms per moleclue, and Aroclor 1260 has six or more, making them among the most stable compounds in this chemical class [6].

Since 1979, the manufacture, processing, distribution, and use of PCB's has been banned in the United States [6]. However, because these chemicals are so stable, the major source of Aroclor 1254 and Aroclor 1260 release to the environment is an enviromental cycling process of these compounds previously introduced into the environment. The cycle involves volatilization from water and soil into the atmosphere with subsequent removal from the atmosphere via wet or dry deposition, followed by revolatilization [7]. Although biodegradation of Aroclor 1254 and Arolclor 1260 may occur very slowly in the environment, no other degradation mechanisms have been shown to be important in natural systems. Therefore, biodegradation may be the ultimate fate process [7].

PCBs have a significant environmental toxicity to invertebrates, fish, birds, and mammals. PCB toxicity is further enhanced by their ability to bioaccumulate and biomagnify in the food chain [6]. Their persistence in the environment, their ability to bioconcentrate in almost all classes of biota, and their ability to bioconcentrate and biomagnify through the food chain make PCBs a potentially significant hazard to fish, wildlife, and invertebrate resources [6].

Vegetation. CH2M Hill [8] summarized data that show that PCBs are not very toxic to terrestrial plants. Beets grown in soils with PCBs at a concentration of 100 mg/kg (dry weight) had no significant reduction in growth, while a significant reduction in growth of corn was noted at this concentration. Ostrich ferns growing on sediments with PCB residues of 26 mg/kg (mostly Aroclor 1254) showed five-fold increases in somatic mutations (genetic damage), but other plants in the contaminated area were not genetically damaged. While one source states that PCBs in the soil at concentrations of 100 mg/kg (dry weight) had no significant effect on growth of soybeans, another source identifies a 27 percent reduction in growth of soybean plants at this soil concentration and states that the NOEL is 2 to 3 mg/kg. Regardless, all of these values show low phytotoxicities for this class of compounds.

PCBs have been shown to bioconcentrate in both terrestrial and aquatic plants. Studies summarized in Eisler [6] showed dry-weight concentrations in foliage, grasses, aspen leaves, and goldenrod leaves of up to 0.29 ppm, 0.14 ppm, 0.12 ppm, and 0.32 ppm dry weight, respectively. Some of these values exceed the FDA limit of 0.2 ppm for PCBs in feeds for livestock [6]. Crop leaves (soybeans, string beans, and corn) grown on a contaminated site had PCB levels of 30 ppb to 50 ppb [7] BCFs of 10^4 to 10^5 were reported in various species of algae [6]. Although in-tissue concentrations of PCBs may not be toxic to the plants, they could be important as sources of PCBs in higher trophic levels.

Aquatic Life. The federal aquatic life criterion for PCBs for the chronic protection of freshwater aquatic life is 0.014 μg/L [9]. The corresponding criterion from the state of Ohio for PCBs is 0.001 μg/L. In addition, the state of Ohio requires that "Any whole sample of any representative aquatic organism shall not exceed 0.64 mg/kg (wet weight)" [10]. This latter requirement is to protect higher trophic levels from the ingestion of natural foods containing toxic concentrations of PCBs.

The chronic aquatic life standards derive in part from the toxicity of PCBs to aquatic invertebrates and fish. Studies show 96-hour LC_{50}s (acute toxicities) for freshwater invertebrates are usually between 50 μg/L and 800 μg/L. Most 96-hour LC_{50}s for warm water fish are between 100 μg/L and 600 μg/L [11,12,6,7]. Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [11]. However, because of the extent to which PCBs bioaccumulate, more stringent criteria are appropriate [11].

A major concern to aquatic life is the bioconcentration of PCBs. Studies cited in virtually every summary article on PCBs showed concentration factors ranging from 10^3 to 10^5 in freshwater invertebrates and fish [11,12,6,13,7]. PCBs with the highest chlorination (which would include Aroclor 1254 and Aroclor 1260) were accumulated most readily [6]. This ability to bioaccumulate further enhances the toxicity of these compounds [6]. Diet contributes most of the total PCB body burdens of upper-level aquatic carnivores, with diet accounting for 90 percent of the total PCB body burden in brown trout and 51 to 83 percent in striped bass [6]. Elimination of accumulated PCBs is slow, with no elimination by codfish larvae after 12 days and 97.8 percent retention by chironomid (an invertebrate) larvae after 7 days [6].

Wildlife. Because of their ability to bioaccumulate, PCBs have been studied more extensively in wildlife than have most other chemicals. Studies summarized by Eisler [6] show that effects vary among PCB compounds. For example, tissues from cattle that had been dosed with Aroclor 1254 and fed to mink at levels as low as 0.64 ppm fresh weight of diet caused severe reproductive effects. However, Aroclors 1016 and 1221 at dietary concentrations of 2 ppm produced no adverse reproductive effects in mink over a 9-month period, nor did Aroclor 1242 at 5 ppm during a similar period.

Aroclor 1260 has relatively low oral toxicity, at least to rats. Micromedex, Inc. [7] cites several studies in which laboratory rats were fed Aroclor 1260 at concentrations of 100 ppm to 1,250 ppm in the diet for periods ranging from 2 months to 21 months. Although sublethal effects such as reduced reproductive success, liver tumors, and retarded growth were noted, these concentrations did not cause large-scale mortality.

Aroclor 1254 has been tested in a number of species of wildlife. LD_{50} data for dietary intake of Aroclor 1254 that were summarized in Eisler [6] and Micromedex, Inc. [7] are presented below.

Raccoon	>50 mg/kg, 8 days
Cottontail rabbit	>10 mg/kg, 12 weeks
Mink	4 mg/kg, no time given
Mink	6.7 mg/kg, 9 months
White-footed mouse	>100 mg/kg, 3 weeks
Norway rat	>75 mg/kg, 6 days
Mouse, PCB-resistant	>250 mg/kg, 18 weeks

Aroclor 1254 apparently is more toxic to rats than is Aroclor 1260. Rats fed Aroclor 1254 at the rate of 1,000 mg/kg in the diet all died in 53 days; mortality started at day 28 [6]. These and other feeding studies suggest that a total intake of about 500 to 2,000 mg of Aroclor 1254 per kg body weight is the lethal level in rats for dietary exposures of 1 to 7 weeks [6].

In the body, PCBs are accumulated primarily in the adipose tissue, skin, and liver [6,13.]. More highly chlorinated congeners have longer half-lives, with a half-life of Aroclor 1260 in humans of 33 to 34 months [7].

Birds are generally more resistant to acutely toxic effects of PCBs than mammals [6]. Studies summarized in Eisler [6] and Micromedex Inc. [7] showed that mallards, ring-necked pheasants, bobwhite quail, and Japanese quail had 5-day LD_{50}s for ingestion of Aroclor 1254 and Aroclor 1260 ranging from 600 ppm to more than 2,000 ppm in the diet. Acute LD_{50}s for European starlings, red-winged blackbirds, and brown-headed cowbirds were all 1,500 mg/kg in the diet [6]. However, sublethal effects can occur at much lower concentrations. For example, 20 ppm in the diet of chickens caused a significant decrease both in the hatchability of eggs and in the viability of the surviving chicks [11]. Delayed reproduction and decreased numbers of eggs occurred in mourning doves fed 10 ppm Aroclor 1254 for 28 days [8].

Bioaccumulation also occurs in birds. Diet is an important route of PCB accumulation, with highest liver concentrations of PCBs in birds that fed on fish, followed by species that feed on small birds and mammals; and on worms and insects. Concentrations were lowest in herbivorous bird species [6]. In general, PCB accumulation is rapid and elimination is slow. For example, in common grackles, the biological half-life of Aroclor 1254 was calculated to be 89 days [6].

The Red Book [11] states, "Evidence is accumulating that PCBs do not contribute to shell thinning of bird eggs." However, this statement was contradicted by Prager [13] and Micromedex, Inc. [7], who indicate that PCBs cause eggshell thinning and reduced reproductive ability. Although Eisler [6] cited several PCB-related instances of eggshell thinning and associated reproductive failure in cormorants, peregrine falcons, bald eagles, and black-crowned night herons. he states. "At present. the evidence implicating PCBs as a major source of eggshell thinning is inconclusive."

REFERENCES

1. USEPA, 1983. Environmental Transport and Transformation of Polychlorinated Biphenyls. Office of Pesticides and Toxic Substances. USEPA. EPA 560/5-83-025. December 1983.
2. ATSDR. 1991. Toxicological Profile for Selected PCBs. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
3. Montgomery. J.H. and Welkom, L.M., 1990. Groundwater Chemicals Desk Reference. Volume I. Lewis Publications.
4. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March. 1995.
5. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
6. Eisler. R., 1986. Polychlorinated Biphenyl Hazards to Fish. Wildlife. and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews. Report 7. Biological Report 85 (1.7). U.S. Department of the Interior. Fish and Wildlife Service, Washington. D.C.
7. Micromedex Inc., 1992. Tomes Plus System. Toxicology. Occupational Medicine and Environmental Series. Volume 14. Denver, Colorado.
8. CH2M Hill, 1989. Preliminary Endangerment Assessment, Lowry Landfill, Denver. Colorado. Prepared for the U.S. Environmental Protection Agency Hazardous Site Control Division under REM IV - Remedial Planning Activities at Selected Uncontrolled Hazardous Waste Sites Zone II. Denver. Colorado.
9. USEPA. 1991. Water Quality Criteria Summary. Washington. D.C.
10. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code. title 3745-Chapter 1. Ohio Environmental Protection Agency.
11. USEPA. 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington. D.C.
12. Johnson, W.W., and M.T. Finley, 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior. Fish and Wildlife Service, Resource Publication 137. Washington, D.C.
13. Prager, J.C. (ed.), 1989. Polychlorinated Biphenyls. Dangerous Properties of Industrial Materials Report. Van Nostrand Reinhold, New York. Vol.9 (3): 81-91.

POLYCYCLIC AROMATIC HYDROCARBONS

GENERAL

Polycyclic aromatic hydrocarbons (PAHs) are a large group of chemicals formed during the incomplete combustion of organic materials. There are over one hundred PAHs, and they are found throughout the environment in air, water, and soil. Seven of the 15 PAHs addressed in this profile are classified as probable human carcinogens [1,2].

CAS NUMBERS

Acenaphthene	83-32-9	Chrysene	218-01-9
Acenaphthylene	208-96-8	Dibenzo(a,h)anthracene	53-70-3
Anthracene	120-12-7	Fluoranthene	206-44-0
Benzo(a)anthracene	56-55-3	Fluorene	86-73-7
Benzo(a)pyrene	50-32-8	Indeno(1,2,3-cd)pyrene	193-39-5
Benzo(b)fluoranthene	205-99-2	Phenanthrene	85-01-8
Benzo(g,h,i)perylene	191-24-2	Pyrene	129-00-00
Benzo(k)fluoranthene	207-08-9		

COMMON SYNONYMS

Polynuclear aromatic hydrocarbons, PNAs, PAHs.

ANALYTICAL CLASSIFICATION

Semivolatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble to 3.93 mg/L [1]
Vapor Pressure: negligible to very low at 25°C [1]
Henry's Law Constant: 6.95×10^{-8} to 1.45×10^{-3} atm-m^3/mole [1]
Specific Gravity: approximately 0.9 to 1.4 at 0 to 27°C [1]
Organic Carbon Partition Coefficient (K_{oc}): 2.5×10^3 to 5.5×10^6 [1]

FATE DATA: HALF-LIVES

Soil: 12.3 days to 5.86 years [3]
Air: 0.191 hours to 2.8 days [3]
Surface Water: 0.37 hours to 1.78 years [3]
Groundwater: 24.6 days to 10.4 years [3]

NATURAL SOURCES

Volcanoes, forest fires, crude oil, and oil shale [1].

ARTIFICIAL SOURCES

Motor vehicles and other petroleum fuel engines, wood-burning stoves and fireplaces, furnaces, cigarette smoke, industrial smoke or soot, and charcoal-broiled foods [1].

FATE AND TRANSPORT

Because the physical and chemical properties of PAHs vary substantially depending on the specific compounds in question, the fate and transport characteristics vary. Thus, the following discussion is presented in very general terms. Some fate characteristics are roughly correlated with molecular weight; so the compounds are grouped as follows [1]:

- Low molecular weight: acenaphthene, acenaphthylene, anthracene, fluorene, and phenanthrene;
- Medium molecular weight: fluoranthene and pyrene; and
- High molecular weight: benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

PAHs are present in the atmosphere in the gaseous phase and sorbed to particulates. They may be transported great distances, and are subject to photodegradation as well as wet or dry deposition [1].

PAHs in surface water are removed by volatilization, binding to particulates and sediments, bioaccumulation, and sorption onto aquatic biota. The low molecular weight PAHs have Henry's Law constants in the range of 10^{-3} to 10^{-5} atm-m^3/mole, and would therefore be expected to undergo significant volatilization; medium molecular weight PAHs have constants in the 10^{-6} range; and high molecular weight PAHs have constants in the range of 10^{-5} to 10^{-8}. Half-lives for volatilization of benzo(a)anthracene and benzo(a)pyrene from water have been estimated to be greater than 100 hours. It has been reported that lower molecular weight PAHs could be substantially removed by volatilization under conditions of high temperature, shallow depth, and high wind. For example, anthracene was found to have a half-life for volatilization of 18 hours in a stream with moderate current and wind. In an estuary, volatilization and adsorption are the primary removal mechanisms for medium and high molecular weight PAHs, whereas volatilization and biodegradation are the major mechanisms for low molecular weight compounds. PAHs can bioaccumulate in plants and animals, but are subject to extensive metabolism by high-trophic-level consumers, indicating that biomagnification is not significant [1].

Potential mobility in soil is related to the organic carbon partition coefficient (K_{oc}). The low molecular weight PAHs have K_{oc} values in the range of 10^3 to 10^4, which indicates a moderate potential to be adsorbed to organic material. Medium molecular weight compounds have values on the order of 10^4, while high molecular weight compounds have values in the 10^5 to 10^6 range. The latter compounds, then, have a much greater tendency to adsorb and resist movement through soil. Volatilization of the lower molecular weight compounds from soil may be substantial. However, some portion of PAHs in soil may be transported to groundwater, and then move laterally in the aquifer, depending on soil/water conditions [1].

HUMAN TOXICITY

General. Ingestion of, inhalation of, or dermal contact with PAHs by laboratory animals has been shown to produce tumors. Reports in humans show that individuals exposed by inhalation or dermal contact for long periods of time to mixtures of PAHs and other compounds can also develop cancer. However, the relationship of exposure to any individual PAH with the onset of cancer in humans is not clear [1]. The available RfDs and weight-of-evidence groups for the PAHs addressed in this profile are presented in Table 1. The available slope factors are presented below. No other toxicity values were available [2,4].

Oral Exposure. Indirect evidence suggests that benzo(a)pyrene may not be readily absorbed following oral exposure in humans. On the other hand, absorption in rats appears to be rapid and efficient. Whether or not there is actually a significant difference between humans and rats in the capacity to absorb benzo(a)pyrene is questionable. It should be noted that the degree of uptake is highly dependent on the vehicle of administration. A NOAEL of 150 mg/kg/day was determined for gastrointestinal, hepatic, and renal effects in rats following acute oral exposure to benzo(a)pyrene or benzo(a)anthracene. LOAELs in the range of 40 to 160 mg/kg/day were determined for developmental and reproductive effects in mice following acute oral exposure to benzo(a)pyrene [1]. An oral slope factor of 7.3 $(mg/kg/day)^{-1}$ for benzo(a)pyrene is based on tumors detected in the forestomachs of rats and mice in various diet studies [2].

Inhalation Exposure. The USEPA does not currently provide inhalation RfCs for any of the PAHs [2,4]. Pure PAH aerosols appear to be well absorbed from the lungs of animals. However, PAHs adsorbed to various particles appear to be poorly absorbed, if at all. The latter are most likely to be removed from the lungs by mucociliary clearance and subsequent ingestion. Lung cancer in humans has been strongly associated with long-term inhalation of coke-oven emissions, roofing-tar emissions, and cigarette smoke, all of which contain mixtures of carcinogenic PAHs. It has been estimated that

TABLE 1
SELECTED TOXICITY DATA FOR PAHS[a]

Compound	CAG Group[b]	Oral RfD (mg/kg/d)	Species	Critical Effect	Experimental Doses (mg/kg/day)	Study Type[c]
Acenaphthene	NR	0.06	Mouse	Hepatotoxicity	NOAEL: 175 LOAEL: 350	SC
Acenaphthylene	D	UR				
Anthracene	D	0.3	Mouse	None observed	NOEL: 1,000	SC
Benzo(a)anthracene	B2	NR				
Benzo(a)pyrene	B2	NR				
Benzo(b)fluoranthene	B2	NR				
Benzo(g,h,i)perylene	D	NR				
Benzo(k)fluoranthene	B2	NR				
Chrysene	B2	NR				
Dibenzo(a,h)anthracene	B2	NR				
Fluoranthene	D	0.04	Mouse	Nephropathy, increased liver wt, hematol alter	NOAEL: 125 LOAEL: 250	SC
Fluorene	D	0.04	Mouse	Decreased RBC, packed cell vol, and hemoglobin	NOAEL: 125 LOAEL: 250	SC
Indeno(1,2,3-cd)pyrene	B2	NR				
Phenanthrene	D	NR				
Pyrene	D	0.03	Mouse	Renal tubular pathology, decreased kidney weights	NOAEL: 75 LOAEL: 125	SC

a. From IRIS [2]. When IRIS values were unavailable, HEAST [4] values were used. RfD = reference dose, NR = not reported

b. CAG = USEPA Carcinogen Assessment Group. B2 = probable human carcinogen; D = not classifiable as to human carcinogenicity.

c. SC = subchronic.

the 8-hour time-weighted average exposure to PAHs in older coke plants was approximately 22 to 33 mg/m^3 [1]. An inhalation slope factor is not available for any of the PAHs [2,4].

Dermal Exposure. Limited *in vivo* evidence exists that PAHs are at least partially absorbed by human skin. An *in vitro* study with human skin indicated that 3% of an applied dose of benzo(a)pyrene was absorbed after 24 hours. Studies in mice indicated that at least 40% of an applied dose of benzo(a)pyrene was absorbed after 24 hours. The carcinogenic PAHs as a group cause various noncancerous skin disorders in humans and animals. Substances containing mixtures of PAHs have been linked to skin cancers in humans. Studies in laboratory animals have demonstrated the ability of benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene to induce skin tumors [1].

ECOLOGICAL TOXICITY

General. The molecular weight of the individual PAHs affects their mobility and solubility in the environment, with lower weight compounds generally being more volatile and soluble than higher weight compounds, which have strong sorption properties. In aquatic environments, PAH partitioning in sediments occurs in an equilibrium process, with a potential for localized occurrences of high levels of dissolved PAHs [5,6]. PAHs can bioaccumulate in plants and animals, but do not biomagnify in food chains. Inter- and intraspecies responses to carcinogenic PAHs are variable, and some PAHs tend to inhibit the carcinogenicity of other compounds in mammals [7]. A variety of adverse effects on aquatic and terrestrial animals has been observed.

Vegetation. Plants absorb PAHs from soils through their root systems, and can translocate them to above ground parts. Lower weight PAHs are absorbed more readily than other PAHs [7]. Airborne deposition of particulate PAHs, and the subsequent adsorption to the skins of fruits and vegetables, accounts for reported higher PAH concentrations in aboveground versus underground plant parts. Soil concentrations of benzo(a)pyrene typically may reach 1,000 mg/kg; concentrations for total PAHs typically exceed benzo(a)pyrene concentrations by at least one order of magnitude. PAH concentrations in vegetation typically range from 20 to 1,000 μg/kg [6]. Some plants biocentrate PAHs in their oily parts (e.g., seeds) above levels in surrounding soils, but this does not appear to be typical [6]. In limited studies on PAHs in plants, phytotoxic effects were rare; photosynthetic inhibition in algae has been documented [7,6]. Some vascular plants catabolize benzo(a)pyrene [6], and PAHs synthesized by plants may act as growth hormones [7,8]. Plants may serve as a pathway for exposure of higher-order consumers to toxic levels of PAHs.

Aquatic Life. Most PAHs in aquatic environments tend to sorb to sediments, and sediment-associated PAHs have accounted for up to 77 percent of the steady-state body burden in benthic amphipods [7]. Absorption and assimilation of PAHs vary widely among species and according to the specific compound. Crustaceans and fish appear better able to assimilate, metabolize, and eliminate PAHs than do molluscs and polychaetes [7,8]. Fish appeared to detoxify benzo(a)pyrene as quickly as it was absorbed in water-only exposures [9]. Little potential for biomagnification through aquatic food chains exists, and bioconcentration factors range widely. A 2- to 3-day exposure BCF of 485 was reported for anthracene in fathead minnows, and a 24-hour BCF of 12 was reported for benzo(a)pyrene in bluegill [7].

Toxic effects of PAHs in fish include liver, thyroid, gonad, and skin tumors. Phenanthene has an LC_{50} of 370 μg/L in grass shrimp, and benz(a)anthracene has an LC_{87} of 1,000 μg/L in bluegill [7]. In the Black River, Ohio, where sediment PAH levels were 10,000 times those in a control location, brown bullheads showed elevated concentrations of lower molecular weight PAHs in their livers and a higher incidence of liver tumors [5,7,8]. Dissolved fluorene introduced into pond waters resulted in reduced growth in bluegill at 0.12 mg/L, and in increased vulnerability to predation at 1.0 mg/L [7].

There are no promulgated federal or state aquatic life water quality criteria for any of the PAHs, though the USEPA has proposed a chronic criterion of 6.3 μg/L and an acute criterion of 30 μg/L for phenanthrene in fresh waters [10,11].

Wildlife. PAH toxicity studies in animals are mostly confined to laboratory experiments. Many PAHs can produce tumors in skin and epithelia tissues in all animal species tested, with malignancies induced by microgram acute exposures. Some carcinogenic PAHs can pass across skin, lungs, intestines, and placenta in mammals. Target organs are diverse, and the tissue affected is dependent on the compound and method of exposure. For example, dietary benzo(a)pyrene caused leukemia, lung adenoma, and stomach tumors in mice. Ancillary tissue damage may accompany carcinomas [7]. Selective effects based on age and gender of the receptor have also been observed [8,12,9,13]. Mammals do not tend to accumulate PAHs, which is likely due to the rapid metabolism of these compounds. For example, the biological half-life of benzo(a)pyrene in rat blood and liver was 5 to 10 minutes [7].

There is a scarcity of data on PAHs that are not carcinogenic [14]. Many chemicals, including other PAHs, modify the carcinogenic actions of PAHs in laboratory animals. Inhibitors of PAH-induced tumors include selenium, vitamins A and E, flavones, and ascorbic acid [7]. LD_{50} values also range widely: acute oral LD_{50} values for rodents range from 50 mg/kg body weight for benzo(a)pyrene to 700 mg/kg for phenanthrene, to 2,000 mg/kg for fluoranthene. Chronic oral carcinogenicity values for rodents include 40 mg/kg for benzo(b)fluoranthene, 72 mg/kg for benzo(k)fluoranthene, and 99 mg/kg for chrysene [7].

In a study on mallards, no mortality or visible toxic effects were observed over 7 months during which birds were fed diets containing 4,000 mg/kg PAHs, though heptatic changes were observed. Sax [9] reports that single oral doses of 250 ppm benzo(a)pyrene were not acutely toxic to ducks or chickens.

REFERENCES

1. ATSDR. 1990. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. NTIS No. PB91-181537. December 1990.
2. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
5. Cura, J.J., B. Potocki, and M.L. Soczek, 1992. Distribution of PAH Compounds in Aquatic Biota. Superfund Risk Assessment in Soil Contamination Studies. ASTM STP 1158.K. Hoddinott and D. Knowles, eds. American Society for Testing and Materials. Philadelphia.
6. Edwards, N.T., 1983. Polycyclic Aromatic Hydrocarbons (PAHs) in the Terrestrial Environment-A Review. Journal of Environmental Quality 12(4):427-441.
7. Eisler, R., 1987. Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates, A Synopsis. Biological Report 85(1.11), Contaminant Hazard Reviews Report 11. U.S. Fish and Wildlife Service, Laurel, Maryland.
8. Micromedex, Inc., 1992. Tomes Plus System. Toxicology, Occupational Medicine and Environmental Services. Volume 14. Denver, Colorado.
9. Sax, N.I. (ed.), 1985a. Benzo(a)pyrene. Dangerous Properties of Industrial Materials Report. January/February 1985, pp. 42-49.
10. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
11. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
12. Sax, N.I. (ed.), 1984. Chrysene. Dangerous Properties of Industrial Materials Report. July/August 1984. pp. 83-100.
13. Sax, N.I. (ed.), 1985b. Benzo(k)fluoranthene. Dangerous Properties of Industrial Materials Report. January/February 1985, pp. 37-39.
14. USEPA, 1980. Ambient Water Quality Criteria for Polycyclic Aromatic Hydrocarbons. EPA 440/5-80-069.

SELENIUM

CAS NUMBER

7782-49-2

COMMON SYNONYMS

Vandex; CI77805; selenium base; selenium dust; colloidal selenium; selenium homopolymer. [1]

ANALYTICAL CLASSIFICATION

Metal.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 4.81 at 20°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Selenium is a naturally-occurring element. The concentration of selenium in minimally disturbed soils varies tremendously. A collection of 1,267 soil samples from across the conterminous U.S. determined that 80 percent were less than or equal to 0.5 ppm, with a geometric mean of 0.26 ppm, but with a maximum of 5 ppm [3]. Of fourteen samples collected around Ohio, 43 percent were found to contain selenium at levels ranging from 0.7 and 5 ppm [3].

FATE AND TRANSPORT

The behavior of selenium in the environment is dependent upon its oxidation state, and the behavior of the chemical compounds formed as a result of the differing oxidation states. In addition, the oxidation state of selenium in the environment is dependent upon a number of environmental factors, including pH, Eh, and biological activity, etc. For releases of selenium to soils, pH and Eh will be the primary determining factors for its fate and transport. Elemental and/or inorganic selenium may undergo microbial methylation (to dimethyl selenide and dimethyl deselenide), ultimately being volatilized to the atmosphere. Temperature, however, will moderate the methylation of selenium; reductions in temperature from 20°C to 4°C resulted in a methylation rate reduction of 90%. Acidic soil conditions favor the predominance of selenides. Selenides are insoluble and are expected to be immobile in the soils. Neutral to alkaline soil conditions favor the predominance of selenates. Selenates are expected to be very mobile in soils, given their high solubility and low sorption potential, and represent a potential for leaching to unprotected groundwaters. For water-soluble selenium compounds (i.e., selenates), terrestrial plant uptake represents a removal/transport mechanism of concern, but will be influenced by a variety of environmental factors (e.g., pH, soil type, reduction oxidation (redox) potentials, etc.) [1].

Selenium released to surface waters is expected to be found in the form of salts of selenic and selenious acids. Salts of selenic acid (such as sodium selenate) are generally found in aerobic, alkaline waters, and are expected to be highly mobile in the aquatic environment. Salts of selenious acid (selenite salts) are found in neutral to acidic waters, and show less environmental mobility than do selenate salts. Under acidic conditions, however, selenite is readily reduced to elemental selenium; selenate, as well, is converted to elemental selenium, but more slowly. Elemental selenium will be stable over a wide range of pH and redox conditions. Aquatic organisms, however, will convert selenium to selenoamino acids and, subsequently, methylated selenium compounds. Neither metabolic product is expected to exist long in the aquatic environment, with the methylated forms volatilizing rapidly to the atmosphere. Selenium in the aquatic environment has been demonstrated to bioaccumulate ($\log_{BAF} = 3.60$), bioconcentrate ($\log_{BCF} = 3.27$), and, potentially, biomagnify in aquatic organisms [1].

Atmospheric concentrations of selenium are generally found as inorganic compounds such as selenium dioxide and hydrogen selenide, and organic compounds such as dimethyl selenide and dimethyl diselenide. Dry and/or wet deposition of selenium compounds is expected to account for some removal of these materials from the atmosphere [1].

HUMAN TOXICITY

General. Selenium is considered an essential element. Toxic effects may occur, however, when too much selenium is taken into the body. The major target of selenium toxicity is the lungs, with the heart, liver and kidneys also being affected. Selenium is considered to be genotoxic [1]. The USEPA placed selenium in weight-of-evidence cancer Group D, indicating that it is not classifiable as to human carcinogenicity [4].

Oral Exposure. A chronic oral RfD of 0.005 mg/kg/day is based on a NOAEL of 0.015 mg/kg/day for clinical selenosis in a human epidemiology study [4]. Selenium is readily absorbed following oral exposure. Acute oral LD_{50} values of 4.8 - 7 mg/kg in rats, 3.2 - 3.5 mg/kg in mice, 2.3 mg/kg in guinea pigs and 1.0 mg/kg in rabbits have been reported for selenium [1]. In humans, selenium exposure has resulted in death, but the fatal dose is not known. Following accidental ingestion of selenium, effects on the lungs (pulmonary edema, breathing difficulties), upset stomachs and muscular weakness have been noted. The dose resulting in these effects is not known. Symptoms reported in people who ingested selenium over a long period of time include loss of hair, loss of and poorly formed nails, problems with walking, reduced reflexes and some paralysis. These effects occurred at doses greater than or equal to 0.053 mg/kg/day [1]. Selenium has not been found to cause developmental effects in humans or mammals, but birth defects have been found in birds [1]. Most epidemiological studies indicate that selenium is not carcinogenic to humans. In fact, some animal studies suggest that oral selenium may inhibit cancer. An oral Slope Factor for cancer is not available for selenium [4].

Inhalation Exposure. A chronic inhalation RfC is not available for selenium [4]. Selenium is readily absorbed following inhalation exposure. Acute inhalation LC_{50} values in guinea pigs ranged from 1-12.7 mg/m^3 for 2 to 8 hours [1]. Inhaled selenium has not been reported to be fatal in humans. In both humans and animals, the respiratory system is the primary target of inhaled selenium because selenium is an irritant when it comes in contact with water. Short-term exposure to high concentrations of selenium (exact levels not known) results in pulmonary edema, bronchial spasms, symptoms of asphyxiation, and persistent bronchitis [1]. Neurological effects (headaches, dizziness, malaise) have also been noted following short-term inhalation of selenium. Occupational exposure to low concentrations (0.007-0.05 mg/m^3) has resulted in slight tracheobronchitis [1]. Information regarding the potential effects of inhaled selenium on reproduction and development are not available. Inhaled selenium has not been reported to cause cancer in humans or animals, therefore, an inhalation Unit Risk is not available [4].

Dermal Exposure. Contact dermatitis and skin rashes have been reported following both acute and chronic exposure to selenium [1]. This is due to the irritative properties of selenium. Other information regarding the toxicity of selenium following dermal exposure are not available.

ECOLOGICAL TOXICITY

General. Selenium is considered a non-essential trace element for most plants and a required trace element or micronutrient for most animals. Selenium has a comparatively short biological life in various species of organisms for which data are available: 10 days in pheasant; 13 days in voles; 15 days in ants; 28 days in leeches; and 64 days in earthworms [5]. Recent studies suggest that selenium biomagnifies in aquatic and terrestrial food chains. It usually magnifies from two to six times in aquatic food chains [6].

Vegetation. Selenium is readily absorbed in high quantities in some plants, apparently without injury. Selenium bioaccumulation is typically associated with arid and semi-arid soil regions of the western United States where selenium-containing geologic deposits are abundant and alkaline soils are common. Because soil parent materials are low in selenium most forage and grain crops in Ohio would typically contain <0.05 ppm selenium in their tissues [7]. A suggested maximum concentration value of selenium in plants is given at 3 to 10 ppm to avoid animal health problems [8]. Selenium in soil is more soluble under alkaline conditions. Selenium accumulators can tolerate extremely high selenium concentrations without injury. The primary indication of selenium injury in nontolerant plants is growth inhibition. A symptom of selenium toxicity in grains is white chlorosis of some or all of the leaves [7].

Aquatic Life. Impacts of selenium in surface waters on aquatic animal species have been noted at concentrations of 0.8 mg/L [8]. The lowest concentration of selenium that results in the impairment of mature fish is 0.25 mg/L and selenium at 0.003 mg/L has harmful effects on fish fry [9]. Field and laboratory data suggest that selenium at concentrations greater than 0.002 to 0.005 mg/L can be bioconcentrated in food chains and cause toxicity and reproductive failure in fish [6]. Two- to 4-day LC_{50}s for fish range from 2.0 to 80.0 mg/L [10]. Selenium toxicity of fathead minnows has LC_{50} values of 0.37 to 1.0 mg/L and at 20 mg/L 100 percent mortality occurred [8]. The 48-day LC_{50} for bluegill larvae was 0.4 mg/L at a water hardness of 330 mg/L [6], whereas 100 percent mortality of juvenile bluegills was achieved with a dietary exposure equivalent to 45 ppm selenium (hardness was 18 mg/L). The 96-hour LC_{50} for fathead minnow fry was 2.9 mg/L, and for bluegill juveniles was 40.0 mg/L [7]. Selenium accumulation is affected by water temperature, age of organism, organ or tissue specificity, mode of administration, and other factors [5]. It is noteworthy that selenium in the diet is known to exert a protective influence against mercury poisoning [11]. The federal and Ohio aquatic life chronic freshwater quality criteria are 5.0 μg/L for warmwater and modified warmwater habitats [12,13].

Wildlife. Selenium protects mammals and some birds against the toxic affects of mercury, cadmium, arsenic, thallium, and the herbicide paraquat [5]. There is a danger of selenium toxicity in the diets of terrestrial animals at concentrations in excess of 5 ppm [8]. In terrestrial systems, Byers [14] suggested 4 ppm (dry weight) of selenium in plants as a tolerance limit for animals that consume them and reported 5 ppm to be potentially dangerous. Lemly and Smith [6] suggested that environmental exposures to waterfowl from water, diet, and sediments should not exceed 0.005 ppm in water and 3 ppm (dry weight) in food and sediments to protect waterfowl from reproductive failures and/or mortality through food chain biomagnification effects. Studies with adult mallards indicated that 100 ppm dietary selenium (as sodium selenite) was fatal within 1 month, but that survival was high at 25 ppm after 3 months. Poor egg hatchability was recorded at 25 ppm, but not at 10 ppm [5].

REFERENCES

1. ATSDR. 1989. Toxicological Profile for Selenium. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
2. Merck. 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. United States Geological Survey (USGS), 1984. Elemental Concentrations in Soils and Other Surficial Material of the Conterminous United States. USGS Professional Paper 1270, U.S. Department of the Interior. United States Government Printing Office. Washington. D.C. 105 pp.
4. USEPA. 1995. Integrated Risk Information System (IRIS). Data base. Online. March. 1995.
5. Eisler, R., 1985. Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews. Report 14. Biological Report 85 (1.14). U.S. Department of the Interior. Fish and Wildlife Service, Washington. D.C.
6. Lemly, A.D. and G.J. Smith, 1987. Aquatic cycling of selenium: implications for fish and wildlife. Fish and Wildlife Leaflet 12. U.S. Fish and Wildlife Service. Washington. D.C.
7. U.S. Fish and wildlife Service. 1978, Impacts of Coal-Fired Power Plants on Fish. Wildlife. and their Habitats. FWS/OBS-78/29.
8. USEPA. 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
9. Snyder. B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
10. USEPA. 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
11. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Vol. I and II. Office of Water and Waste Management. Washington, D.C. EPA-440/4-79-029.
12. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
13. OEPA. 1991. Ohio Water Quality Standards. Ohio Administrative Code. Title 3745-Chapter 1. Ohio Environmental Protection Agency.
14. Byers, H.G., 1935. Selenium occurrence in certain soils of the United States, with a discussion of related topics. U.S. Dept. of Agriculture Tech. Bull. 482. 47 pp.

SILVER

CAS NUMBER

7440-22-4

COMMON SYNONYMS

Argentum; Argentum crede; CI77820; shell silver; silver atom; silver colloidal; silflake; silber. [1]

ANALYTICAL CLASSIFICATION

Metal.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 10.49 at 15/4°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Silver is a naturally-occurring element whose average abundance is 0.1 ppm in the earth's crust and 0.3 ppm in soil [1].

FATE AND TRANSPORT

Silver is a white metal with a face-centered cubic structure. With the exception of gold, no other metal is more malleable or ductile. Silver is not appreciably attacked by water, atmospheric oxygen, or most acids (with the exception of dilute nitric acid and hot concentrated sulfuric acid). It is insoluble in water, but solubilizes in fused alkali hydroxides (in the presence of air), in alkali cyanides (in the presence of air), and in fused alkali peroxides. Additionally, most salts of silver are photosensitive [2].

Silver released to soils under oxidizing conditions will be found primarily in compounds with bromide, chloride, and/or iodide; silver released to soils under reducing conditions will be primarily in the form of free silver metal and/or silver sulfide. The fate and transport, then, of silver released to soils is a function of the form of silver-containing material/compound released (i.e., elemental silver versus silver nitrate). In addition, the mobility of silver through soils is influenced by: the drainage rate of the soil (silver is readily removed from well-draining soils); the reduction-oxidation (redox) potential and pH of the soil, which affects the ability of manganese and iron (among others) to immobilize silver; and organic matter, which tends to form complexes with silver. Plants account for another mechanism of silver removal from soils since plants will take silver from soils into the root system. Biodegradation and/or biotransformation of silver is expected to be very restricted since silver proves toxic to most microorganisms [1].

Silver released to waters will be found primarily as sulfates, bicarbonates, sulfate salts, chlorides, and particulate-associated matter. Sorption appears to be the primary process affecting partitioning of silver through sediment layers in waters, with silver being sorbed readily by compounds such as manganese dioxide. The redox potential and pH of waters will affect the ability of silver to sorb to organic matter therein. Bioconcentration of silver in aquatic organisms represents another fate/transport process of significant concern, given the bioconcentration factor ($\log_{BCF} = 4.82$) for silver. In addition, silver is slowly bioaccumulated by aquatic organisms ($\log_{BAF} = 1.41$). Biomagnification through the trophic levels is expected to be minimal, however. As with silver released to soils, silver released to waters is not expected to undergo significant biodegradation/biotransformation given its inherent toxicity [1].

Atmospheric concentrations of silver will primarily be found as particulate-associated matter and/or fine particles of metallic silver. The major forms of atmospheric silver include: metallic silver, silver sulfide, silver sulfate, silver carbonate, and silver halides. Silver found in any of these forms may be subject to long-range transport, and will eventually be removed from the atmosphere via dry or wet deposition; up to 50% of silver released to the atmosphere from industrial operations has been demonstrated to travel up to 100 km prior to deposition [1].

HUMAN TOXICITY

General. The major targets of silver toxicity are the respiratory system following inhalation exposure and the skin following inhalation, oral and dermal exposure [1]. Data suggest that silver is a mutagen. The USEPA has placed silver in weight-of-evidence cancer Group D, indicating that it is not classifiable as to human carcinogenicity [3].

Oral Exposure. A chronic oral RfD of 0.005 mg/kg/day is based on a LOAEL of 0.014 mg/kg/day for argyria in a long-term study in humans [3]. Approximately 20% of an oral dose of silver is absorbed through the gastrointestinal tract [1]. Ingested silver has not been reported to be fatal to humans, and LD_{50} values are not available for animals. Short- and long-term ingestion of silver results in argyria (grey or blue-grey discoloration of the skin) in humans. The dose associated with argyria is not known. Argyria is considered to be more of a cosmetic problem rather than a health problem. Information is not available regarding the potential effects of silver on reproduction or development in humans. There is no evidence that silver causes cancer in humans or animals and, therefore, an oral Slope Factor is not available [3].

Inhalation Exposure. A chronic inhalation RfC is not available for silver [3]. Silver is absorbed through the respiratory tract, but the extent of absorption is not known. Inhaled silver has not been reported to be fatal to humans, and LC_{50} values are not available for animals. Occupational exposure to 0.039 to 0.378 mg/m^3 has resulted in effects on the respiratory system (sneezing, stuffiness, runny nose, sore throat, cough, wheezing, chest tightness) and on the gastrointestinal system (abdominal pain) [1]. Occupational exposure also results in argyria. Information is not available regarding the potential effects of silver on reproduction or development in humans. There is no evidence that silver causes cancer in humans or animals, and therefore, an inhalation Unit Risk is not available [3].

Dermal Exposure. Silver has not been reported to be fatal in humans or animals following dermal exposure. Argyria and mild allergic responses are the only known effects of dermal exposure to silver [1]. The doses that elicit these effects are not known.

ECOLOGICAL TOXICITY

General. Silver is not an essential element for plants or animals. Silver toxicity ranks second only to mercury among the heavy metals [4]. Many of its salts, such as silver chloride, sulfide and arsenate, are insoluble [5].

Vegetation. No reports of silver toxicity in plants growing under natural conditions were found. Under man-induced conditions, silver toxicity to corn was reported at 0.0098 $\mu g/ml$ and 0.0049 $\mu g/ml$ was fatal to lupines [6]. Silver tends to be retained in surface soil at a pH greater than 4, especially in soils with a high concentration of organic matter. In plants, silver has a tendency to accumulate in the root [7]. The ratio of silver content in plants to soil has been given as 1:1.5. Such a ratio must be used with caution because the silver content of plants has a very wide range [7].

Aquatic Life. Silver nitrate and sulfate are relatively soluble compounds of silver and are considered toxic to aquatic life. Silver is not present in aquatic animals at very high concentrations because most of its compounds are virtually insoluble in water and because silver has a very short biological half-life [5]. Extremely low concentrations of silver, as low as 0.0000001 mg/L, have been found to be harmful to sensitive fish species. LC_{50} values for fish range from 0.003 mg/L for silver nitrate to 250 mg/L for silver thiosulfate. However, most reported LC_{50}s were between 0.003 and 0.1 mg/L [5]. Fish are capable of accumulating silver from water, however, the food chain is not an important route of silver accumulation for animals at higher trophic levels [4]. The federal chronic freshwater quality criterion for silver is 0.12 $\mu g/L$ based on water hardness of 400 mg/L $CaCO_3$ [8]. The state aquatic life habitat and water supply standard for silver is 17.0 $\mu g/L$ based on water hardness of 400 mg/L $CaCO_3$ [9].

Wildlife. No references have been found which discuss or report toxic effects of silver on wildlife under natural conditions. Silver is a general microconstituent of many animals. Although the presence of silver in most animals suggests that it might serve some purpose, its role in animal metabolism is still unknown [7]. Long-term experiments with rats and rabbits concluded that ingestion of silver in drinking water at a dose of 0.0025 mg/kg body weight did not produce any detrimental effects. Doses of 0.025 mg/kg body weight affected the rats' reflexes and rabbits' immunological activity [7]. Field studies exposing sheep ewes to as much as 10 mg/kg/day failed to produce clinical signs of toxicity [10].

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Silver. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1990.
2. Merck, 1989. The Merck Index, Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
4. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. Vol. I. Office of Water and Waste Management, Washington, D.C. EPA-440/4-79-029.
5. Snyder, B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
6. Gough, L.P., H.T. Shacklette, and A.A. Case, 1979. Element Concentration Toxic to Plants, Animals, and Man. U.S. Geological Survey Bulletin. No. 466. Washington, D.C.
7. Taylor, M.C., A. Demayo and S. Reeder, 1980. Inorganic Chemical Substances - Silver, in Guidelines for Surface Water Quality. Vol. I.
8. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
9. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.
10. Younger, R.L., and H.R. Crookshank. 1978. Chronic exposure of sheep of silver iodide. Water, Air, and Soil Pollution, V.9, No. 3, p. 281-287.

THALLIUM

CAS NUMBER

7440-28-0

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Negligible at 25°C [2]
Henry's Law Constant: ND
Specific Gravity: 11.85 [1]
Organic Carbon Partition Coefficient: ND

BACKGROUND CONCENTRATIONS

Thallium is a naturally-occurring element. It can be found as crookesite in Sweden, as lorandite in Greece, and as hutchinsonite in Switzerland. The estimated occurrence of thallium within the Earth's crust is 0.7 ppm [1]. No data on thallium were gathered as part of the 1984 Department of the Interior survey of conterminous United States soils [3]. Therefore, no reference point other than the 0.7 ppm world-wide average is available for Ohio soils.

FATE AND TRANSPORT

Elemental thallium is a bluish-white, very soft, inelastic, easily fusible, heavy metal. It will oxidize superficially in air forming a coat of thallium oxide. It will react with nitric and/or sulfuric acids, but only slightly so with hydrochloric acid [1]. Thallium exists in either monovalent (thallous) or trivalent (thallic) forms; thallous being much more common. Thallic salts are readily reduced to thallous salts; virtually all are chemically reactive with air and moisture. Volatilization of thallium and its salts is not expected to occur at ambient temperatures and pressures. Elemental thallium is insoluble in water; thallium salts show a moderate to high degree of solubility (i.e.: thallium sulfide exhibiting solubility to 200 mg/L; and thallium fluoride exhibiting solubility to 780 g/L) [2]. Therefore, thallium is expected to be relatively mobile in aquatic environments and/or moist-to-wet soils. Thallium shows some tendency to bioconcentrate in aquatic organisms [4].

HUMAN TOXICITY

General. In humans, ingestion of large amounts of thallium can affect the nervous system, lung, heart, liver, and kidney [4]. The USEPA currently provides no toxicity values for metallic thallium [5,6]. Oral RfD values are available, however, for many thallium compounds and are based on the oral RfD of 0.00008 mg/kg-day for thallium sulfate [5]. This RfD is based on a NOAEL of 0.25 mg/kg-day for no adverse effects in a subchronic study in rats [5].

Oral Exposure. Animal studies indicate that thallium is completely absorbed when ingested. Evidence also suggests that thallium is well absorbed in humans. Estimates of the oral LD_{50} for rats vary from 32 to 39 mg/kg. A NOAEL (for death) of 0.2 mg/kg/day for 90 days was determined in rats. Male rats receiving 0.7 mg/kg/day (the LOAEL) for 60 days experienced adverse reproductive effects. The most likely route of human exposure is via direct ingestion. Indirect ingestion of dust may occur following inhalation [4].

Numerous human deaths have occurred following oral exposure to thallium. Damage to several systems have been reported, including the nervous system, cardiovascular system, liver, kidney, and muscles [4]. At physiological pH, thallium is soluble. The exact mechanism of toxicity is unclear; inhibition of enzymatic reactions and/or oxidative phosphorylation are the most likely toxic actions. Thallium poisoning in humans is insidious with four generalized stages. They are as follows:

(1) Immediate (3-4 hours): nausea, vomiting, diarrhea, and possibly hematemesis.

(2) Intermediate (hours to days): central nervous system dysfunction, peripheral nervous system dysfunction, autonomic nervous system dysfunction, ophthalmologic effects, and dermal effects.

(3) Late (2-4 weeks): dry and scaly skin, white stripes across nails, and scalp/facial hair loss;

(4) Residual (months): central/peripheral nervous system abnormalities (ataxia, tremor, foot drop, memory loss).

Thallium is an acknowledged cumulative poison. It has an average lethal adult dose of 1 g of soluble thallium salts [4,7]. Elemental thallium has shown lethality at a dosage of 4.4 mg/kg [8].

Inhalation Exposure. No reliable information was located on pulmonary absorption of thallium [4]. Occupational studies indicate that thallium may adversely affect the human nervous system following inhalation [4].

Dermal Exposure. No reliable information was located on the dermal absorption or adverse health effects of thallium following dermal contact [4].

REFERENCES

1. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
2. USEPA, 1980. Ambient Water Quality Criteria for Thallium. EPA 440/5-80-074. United States Environmental Protection Agency, Washington, D.C.
3. USGS, 1984. Elemental Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1720, U.S. Department of the Interior. United States Government Printing Office, Washington, D.C. 105 pp.
4. ATSDR, 1990. Toxicological Profile for Thallium. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.
5. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
7. Ellenhorn, M.J., and BarceCoux, D.G., 1988. Medical Toxicology: Diagnosis and Treatment of Human Poisoning. Elsevier Science Publishing Company, Inc. New York, NY. 1512 pp.
8. National Institute for Occupation Safety and Health, 1991. Registry of Toxic Effects of Chemical Substances (RTECS), Volume I-III. United States Department of Health and Human Services. Cincinnati, OH.

TOLUENE

CAS NUMBER

108-43-2

COMMON SYNONYMS

Methylbenzene.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 534.8 mg/L at 25°C [1]
Vapor Pressure: 28.4 mm Hg at 25°C [1]
Henry's Law Constant: 5.94 x 10^{-3} atm-m^3/mole (temperature not given) [1]
Specific Gravity: 0.866 at 20/4°C [2]
Organic Carbon Partition Coefficient: 37 to 178 [1]

FATE DATA: HALF-LIVES

Soil: 4 to 22 days [3]
Air: 10 hours to 4.3 days [3]
Surface Water: 4 to 22 days [3]
Groundwater: 1 to 4 weeks [3]

NATURAL SOURCES

Volcanoes, forest fires, and crude oil [1].

ARTIFICIAL SOURCES

Gasoline, fuel oils, automobile exhaust, chemical industry, paints and lacquers [1].

FATE AND TRANSPORT

Much of the toluene released to surface soil will be lost to volatilization. It is mobile in soils and will leach to groundwater. Biodegradation occurs slowly in soil and groundwater, but is inhibited by high concentrations. Under ideal conditions of low concentration and acclimated microbial populations, rapid biodegradation may occur. Losses from surface water occur due to volatilization and biodegradation. It will not significantly adsorb to sediment or bioconcentrate in aquatic organisms. In the atmosphere it will degrade or be washed out with rain [1].

HUMAN TOXICITY

General. Toluene acts primarily on the central nervous system [4]. The USEPA has placed toluene in weight-of-evidence Group D: that is, it is not classifiable as to human carcinogenicity [5].

Oral Exposure. A chronic RfD of 0.2 mg/kg/day is based on a NOAEL of 223 mg/kg/day for changes in liver and kidney weights in a subchronic oral study in rats. The LOAEL in this study was a dose of 446 mg/kg/day [5]. Toluene is absorbed more slowly from the gastrointestinal tract than from the lungs [6]. The acute oral LD_{50} for adult rats is in the range of 5,000 to 7,300 mg/kg [4,6]. Brain damage was noted in mice receiving 1,250 mg/kg/day by gavage for 13 weeks [6].

Inhalation Exposure. The RfC of 0.4 mg/m^3 is based on a LOAEL of 88 ppm for central nervous system effects observed in humans following inhalation exposure [5]. Toluene is rapidly absorbed following inhalation by humans and animals [6]. The inhalation LC_{50} in mice is 5,300 ppm for an 8-hour exposure. Exposure of humans by inhalation to 200 ppm for 8 hours produced mild fatigue, weakness, confusion, lacrimation, and tingling of the skin. At 600 ppm, additional effects included euphoria, headache, dizziness, dilated pupils, convulsions, and nausea. After 8 hours at 800 ppm, symptoms were more pronounced; effects included nervousness, muscular fatigue, and insomnia persisting for several days. Exposure to concentrations of 10,000 to 30,000 ppm could lead to narcosis and death. Chronic abusive inhalation of toluene vapors by humans produces central nervous system impairment and emotional and intellectual disturbances. Uptake in the various brain regions is widespread due to the high lipid solubility of toluene and the high lipid content of the brain. Effects on animals following high levels of exposure include hearing loss, kidney effects, and lung lesions. High level oral intake by animals has resulted in weight increases in the liver and kidney, and brain tissue damage [4].

Dermal Exposure. The absorption of toluene through human skin is slow, falling within the range of 14 to 23 $mg/cm^2/hour$. Dermal contact with toluene by humans may cause skin damage. Application of toluene to the eyes of rabbits reportedly resulted in moderately severe injury [6].

REFERENCES

1. Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. II: Solvents. Lewis Publishers, Inc. Chelsea, Michigan. 546 pp.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.

3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko. 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide. Volume 2. Cambridge, MA. July 1989.
5. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March, 1995.
6. ATSDR, 1989. Toxicological Profile for Toluene. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.

VANADIUM

CAS NUMBER

7440-62-2

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble at 20°C [1]
Vapor Pressure: ND
Henry's Law Constant: ND
Specific Gravity: 6.11 at 18.7/4°C [1]
Organic Carbon Partition Coefficient: ND

BACKGROUND CONCENTRATIONS

Vanadium is a naturally-occurring element. The earth's crust is estimated to be comprised of 0.01 percent vanadium (by weight). Elemental vanadium does not occur in nature [2], but may be found in over 65 known minerals including patronite (polysulfide), vanadinite, roscoelite, and carnotite [3]. In a 1984 United States Geological Survey (Department of the Interior), 1,319 total soils samples were gathered from across the conterminous United States and analyzed for vanadium content. Of the total samples gathered, 1,294 showed vanadium content in some concentration ranging from less than 7 ppm up to 500 ppm. Fourteen percent of the total soils samples gathered showed vanadium concentrations to be from less than 7 ppm up to 20 ppm; 28 percent showed concentrations of vanadium to be greater than 100 ppm up to a maximum of 500 ppm; geometric mean concentration of vanadium was 58 ppm. Sixteen soils samples were gathered in (or on a shared border of) Ohio: one showed vanadium concentrations from less than 7 ppm up to 20 ppm; two showed concentrations from >20 ppm up to 50 ppm; seven showed concentrations from >50 ppm to 70 ppm; three showed concentrations from >70 ppm up to 100 ppm; and three showed vanadium concentrations from >100 ppm up to 500 ppm (no maximum value for Ohio soils is noted) [4].

FATE AND TRANSPORT

Elemental vanadium may be found in the following forms: light gray or white lustrous powder; fused hard lumps; or, body-centered cubic crystals. Vanadium does not tarnish in air, nor does it appreciably react with air or moisture at ambient temperatures. It may exist in any of six oxidation states (1^-, 0, 2^+, 3^+, 4^+, and 5^+). In the natural environment, elemental vanadium exhibits a strong reducing ability, and will reduce mercuric and/or ferric salts to mercurous/ferrous salts (among others). It is not readily attacked by acids at ambient temperatures, but will react with heated acids [3]. Elemental vanadium can be expected to be relatively immobile in the environment, owing to its negligible solubility and vapor pressure. Vanadium compounds and complexes, however, exhibit varying degrees of solubility, volatility, etc., and therefore have varying degrees of mobility. The most likely way for it to get into the air is when fuel oil and coal are burned, as it is naturally present in both [1,3].

HUMAN TOXICITY

General. Elemental vanadium is considered to be nontoxic; however, some compounds of vanadium, especially the oxides, are toxic [2]. Inhalation of concentrated vanadium-containing dusts can cause coughing, sore throat, and eye irritation [1]. The USEPA has not placed vanadium in any weight-of-evidence group [5,6].

Oral Exposure. A chronic RfD of 0.007 mg/kg/day is based on a NOAEL of 5 ppm determined for rats in a chronic drinking water study [5]. The absorption of vanadium through the gastrointestinal tract is low. No more than 2.6% was absorbed from the GI tract of rats after 3 days. The acute oral LD_{50} for sodium metavanadate in rats is 41 mg/kg. The LOAEL in humans for vanadium pentoxide is 0.1 mg vanadium/kg (respiratory irritation). Some minor birth defects were observed in the offspring of rats receiving vanadium in drinking water while pregnant. Information on any possible carcinogenic effects following oral exposure were deemed inadequate [1].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for vanadium [5,6]. The primary route of human exposure to vanadium is via inhalation (of vanadium pentoxide dust/fume) and subsequent pulmonary absorption [7]. Studies in rats indicate that rapid absorption of vanadium in humans may occur following acute inhalation exposure [1]. Once in the body, the most commonly found form of vanadium is vanadate (VO_3^-, 5^+ oxidation state). In this form, vanadate acts as an oxidizing agent and is one of the most potent oxidative-phosphorylase pump reaction inhibitors. Common symptoms of acute vanadium toxicity include, but are not limited to: respiratory tract irritation, rhinitis, wheezing, nasal hemorrhage, cough, sore throat, and chest pain. Chronic toxicity symptoms include: bronchitis, conjunctivitis, pneumonia, green discoloration of the tongue, and, metallic taste on the tongue [7]. Response to inhalation of vanadium (ore) was demonstrated at a dose as low as 4 mg/kg. Vanadium pentoxide dust/fumes do not exhibit as intense a degree of toxicity by comparison [8].

Dermal Exposure. Dermal absorption of vanadium is thought to be very low [1]. No other information was available regarding adverse health effects resulting from dermal exposure to vanadium.

REFERENCES

1. ATSDR. 1990. Toxicological Profile for Vanadium. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1990.
2. Sittig, M., 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Second Edition. Noyes Publications. Park Ridge, New Jersey. 950 pp.
3. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
4. USGS, 1984. Elemental Concentrations in Soils and Other Surficial Material of the Conterminous United States. United States Geological Survey Professional Paper 1270, U.S. Department of the Interior. United States Government Printing Office, Washington, D.C. 105 pp.
5. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March 1994.
6. USEPA, 1995. Integrated Risk Information System (IRIS). On-line data base. March. 1995.
7. Ellenhorn. M.J., and Bareclous. D.G., 1988. Medical Toxicology: Diagnosis and Treatment of Human Poisoning. Elsevier Science Publishing Company, Inc. New York, NY. 1512 pp.
8. National Institute for Occupational Safety and Health. 1991. Registry of Toxic Effects of Chemical Substances (RTECS), Volume I - III. United States Department of Health and Human Services. Cincinnati, OH.

ZINC

CAS NUMBER

7440-66-6

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 7.14 at 25/4°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Zinc is a naturally occurring element essential to many life forms [1]. It is widespread in nature and may be found in many known compounds. The estimated occurrence of zinc in the earth's crust is 0.02 percent by weight [2]. The concentration of zinc in minimally disturbed soils varies tremendously. A collection of 1,248 soils samples from across the conterminous U.S. determined that 87 percent were less than or equal to 74 ppm, with a geometric mean of 48 ppm, but with a maximum as high as 3500 ppm [3]. Zinc concentrations in Ohio farm soils were found to range from 47 to 138 ppm, with a mean value of 75 ppm [4].

FATE AND TRANSPORT

Elemental zinc is a bluish-white, lustrous metal having a distorted hexagonal close-packed structure [2]. It is stable in dry air, but upon exposure to moist air will form a white coating composed of basic carbonate. Zinc loses electrons (oxidizes) in aqueous environments [2]. In the environment, zinc is found primarily in the 2^+ oxidation state. Elemental zinc is insoluble; most zinc compounds show negligible solubility as well, with the exception of elements (other than fluoride) from Group VIIa of the Periodic Table compounded with zinc (i.e., $Zn\ Cl_2$, ZnI_2) showing a general 4:1 compound to water solubility level. In polluted waters, zinc often complexes with a variety of organic and inorganic ligands. Therefore, the overall mobility of zinc in an aqueous environment, or through moist-to-wet soils, may be accelerated by compounding/complexing reactions [1].

Zinc has a tendency to adsorb to soils and sediment/suspended solids in waters. Adsorption to sediments/suspended solids is the primary fate for zinc in aqueous environments, and will greatly limit the amount of solubilized zinc. Zinc is an essential element and, therefore, is accumulated by all organisms. Zinc concentrations in air are relatively low except near industrial sources. Volatilization is not an important process from soil or water [1].

HUMAN TOXICITY

General. Zinc is an essential trace element, therefore, toxic effects can result if too much or too little is taken into the body. The Recommended Dietary Allowances (RDAs) for zinc are 15 mg/day for men and 12 mg/day for women [1]. The major targets of zinc toxicity are the gastrointestinal tract following oral exposure and the lungs following inhalation exposure [1]. Zinc is not mutagenic and has been placed in weight-of-evidence Group D, indicating that it is not classifiable as to human carcinogenicity, by the USEPA [5].

Oral Exposure. A chronic oral RfD of 0.3 mg/kg/day is based on a LOAEL of 1 mg/kg/day for effects on red blood cells in human females [5]. Approximately 20-30% of an oral dose of zinc is absorbed by the gastrointestinal tract [1]. Zinc has not been reported to be fatal to humans and oral LD_{50} values in animals are not available [1]. In humans, gastrointestinal effects (vomiting, abdominal cramps, diarrhea) and hematological effects (anemia) have resulted from oral exposure to doses greater than 2 mg zinc/kg/day. Long-term administration of zinc can result in copper deficiency [1]. In animals, effects on the liver and kidneys, as well as the gastrointestinal and hematological systems, have been reported [1]. Studies in animals indicate that exposure to high doses of zinc (200 to 500 mg/kg/day) results in reduced fetal growth and altered concentrations of zinc and copper in both the mother and fetus [1]. There is no evidence that exposure to zinc affects development or reproduction in humans. There is no evidence that zinc causes cancer in humans or animals following oral exposure, therefore, an oral Slope Factor is not available [5].

Inhalation Exposure. A chronic inhalation RfC is not available for zinc [5]. Zinc is absorbed through the respiratory tract, but the extent of absorption is not known. In humans, death has resulted from exposure to high concentrations (estimated at 97,635 mg/m^3) of zinc-containing smoke [1]. In mice, the reported LCT_{50} (product of lethal concentration and time to kill 50% of the animals) of zinc chloride was 11,800 $mg\text{-}min/m^3$ [1]. Short-term exposure to zinc dust and zinc fumes results in "metal fume fever". This condition is characterized by an acute impairment of pulmonary function. Acute (10-12 minutes) inhalation of 600 mg $zinc/m^3$ as zinc oxide has resulted in nasal passage irritation, cough, chest pain, lung rales, and decreased vital capacity. No symptoms of metal fume fever were reported following exposure to zinc oxide at 14 mg/m^3 for 8 hours, 45 mg/m^3 for 20 minutes, or occupational exposure to 8-12 mg/m^3 [1]. Information is not available regarding effects on reproduction or development in human or animals following inhalation exposure. There is no evidence that inhaled zinc causes cancer in humans or animals. therfore. an inhalation Unit Risk is not available [5].

Dermal Exposure. Zinc has not been reported to be fatal in humans or animals following dermal exposure. Topical application of zinc (in the form of zinc oxide or calamine lotion). however, is used to promote healing of burns and wounds [1].

ECOLOGICAL TOXICITY

General. Zinc is an essential trace element for plants and animals. It is the most mobile of the metals in surface water systems, but only moderately mobile in soil/water systems [7]. Zinc is bioaccumulated by all organisms, but it does not biomagnify in terrestrial or aquatic food chains.

Vegetation. Studies of bulrush, sedge, cattail, and reeds indicate relatively high zinc absorption ability [8]. Bioavailable zinc is readily accumulated in the leaves of many plants; however, it is of low availability to animals. probably due to the formation of insoluble complexes of zinc with calcium and phytic acid in the plants [9]. The phytotoxic level of zinc in the soil ranges from 500 to 2000 ppm, with toxicity being enhanced under acidic soil conditions. The normal range of zinc in leaves of various plants is 15 to 150 ppm. and the maximum suggested concentration in plants to avoid phytotoxicity is 300 ppm [10]. Plant species exhibit a wide range of tolerances to zinc concentrations in soils.

Aquatic Life. Extensive test data are available for zinc effects on aquatic life. The acute lethal toxicity of zinc is greatly affected by water hardness, with soft water being more toxic than hard water. Both an increase in temperature and a reduction in dissolved oxygen also increase zinc toxicity [8]. Zinc is most toxic in aquatic biota at a pH of 8.0. and least toxic at a pH of 6.0 [7]. Fish growth was inhibited by zinc at a concentration of 0.05 to 0.08 mg/L, swimming was impaired at 0.06 to 0.3 mg/L, and reproduction was reduced at 0.05 to 0.88 mg/L [8]. The 96-hour LC_{50} for fathead minnows was 33,000 μg/L at a water hardness of 360 mg/L $CaCO_3$ [11]. The federal chronic freshwater quality criterion for zinc is 343 μg/L based on a water hardness of 400 mg/L $CaCO_3$ [12]. The Ohio aquatic life habitat standard is 340 μg/L based on a water hardness of 400 mg/l $CaCO_3$ [13].

Wildlife. Animals are generally protected from zinc poisoning through plant consumption because high concentrations of zinc are phytotoxic before they accumulate in toxic concentrations in plant tissues eaten by animals [10]. Zinc compounds are relatively nontoxic to animals, particularly mammals, because animals can physiologically regulate the absorption and excretion of this metal. For example, a dietary intake of 2,500 ppm zinc produced no discernable effects in rats, while 10,000 ppm is required to induce high mortality. A zinc concentration of 2.2 g/kg in rats and 1.9 to 2.2 g/kg in rabbits was lethal [9].

REFERENCES

1. ATSDR. 1989. Toxicological Profile for Zinc. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1989.
2. Merck, 1989. The Merck Index. Eleventh Edition. Merck & Company, Inc. Rahway, NJ.
3. USGS, 1984. Elemental Concentrations in Soils and Other Surficial Material of the Conterminous United States. United States Geological Survey Professional Paper 1270, U.S. Department of the Interior. United States Government Printing Office, Washington, D.C. 105 pp.
4. Logan, T.J., and R.H. Miller, 1983. Background Levels of heavy Metals in Ohio Farm Soils. Research Circular 275, Ohio State University, Ohio Research and Developmental Center, Wooster, Ohio. February 1983.
5. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online. March, 1995.
6. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. March, 1994.
7. Golder Associates, Inc., 1991. Final Remedial Investigation for Mosley Road Sanitary Landfill. Denver, Colorado.
8. Snyder, B.D. and J.L. Snyder, 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
9. U.S. Fish and Wildlife Service, 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitats. FWS/OB5-78/29.
10. USEPA, 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
11. USEPA, 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.
12. USEPA, 1991. Water Quality Criteria Summary. Washington, D.C.
13. OEPA, 1991. Ohio Water Quality Standards. Ohio Administrative Code, Title 3745-Chapter 1. Ohio Environmental Protection Agency.

APPENDIX G

EXCERPT FROM SEAD-12 AND SEAD-63 SCOPING PLAN DISCUSSION OF DATA QUALITY OBJECTIVES

Excerpt from Section 2.3.5 (Data Quality Objectives) of the SEAD-12 and SEAD-63 Project Scoping Plan

↓ The actual quantity of Level 1 and Level 2 radiological data (needed to demonstrate compliance with release guidelines) or Level 3 or Level 4 analytical data (needed to compare site data sets to background data sets) is dependent upon the decision error probabilities that are used. For the purposes of comparing site data sets to background data sets, acceptable decision error probabilities of 0.05 for Type One errors (or the α error rate) and 0.05 for Type Two errors (or the β error rate) were selected. A Type One error can be characterized as making a decision that is based upon a false positive result. A Type One error probability of 0.05 can be equated to

there being a 5% probability that this type of error is made. Similarly, a Type Two error can be characterized as a decision that is based upon a false negative result, and a Type Two error probability of 0.05 can be equated to their being a 5% probability that this type of error is made.

The error rates of 0.05 α and 0.05 β will be used to test a null hypothesis, Ho, for each survey unit. The null hypothesis for the radiological survey units at SEADs-12 and 63 is that residual radiation at a survey unit is above a release criterion. The alternative hypothesis, Ha, at these survey units is that residual radiation at a survey unit is present at levels that do not exceed a release criterion. The null hypothesis for comparing survey unit analytical data sets to background data sets is that the survey unit data set is distinguishable from and greater than the background data set. The alternative hypothesis for comparing survey unit to background data sets is that the concentration of a given analyte is indistinguishable from the background data set. Using these stated statistical values (the α and β error rates and the null and alternative hypotheses) and guidance provided in the NRC's NUREG 1505 (NRC 1995) document and the EPA's Statistical Methods for Evaluating the Attainment of Cleanup Standards, Vol. 3 (EPA, 1994) the minimum quantities of data that will be needed to provide sufficient power to either accept the null hypothesis or to reject it in favor of the alternative hypothesis can be determined. Table 3-25 presents the data quantities that were determined using the stated statistical values and the NUREG-1505 and EPA guidance. As can be seen in this table, the minimum number of data points that is required, using conservative estimates of what can be expected at SEADs-12 and 63, is 34 environmental media samples and 17 building surface measurements. For survey units that will be compared to a reference area, this minimum number of samples is the combined number of samples that is required from both the site and background data sets. The minimum number that is required from each survey unit and each background unit is therefore equal to one half of the total, or 17 environmental media samples and 10 building surface measurements. However, for survey units that will not be compared to a reference unit, the listed total number of samples all need to be collected from the survey unit, and therefore, in the case of the building surface measurements, a minimum of 17 measurements will be required. These minimum numbers of samples will be used to assure that the sampling and measurement plans detailed in the Task Plan for the Remedial Investigation section (Section 4) will provide enough data to give the statistical comparisons sufficient power to accept the null hypothesis or reject it in favor of the alternative hypothesis.

Further discussion of the DQOs as they pertain to SEDA is presented in the Generic Installation RI/FS Workplan that serves as a supplement to this RI/FS Project Scoping Plan.

Table 3-25
Seneca Army Depot Activity
SEAD-12, 48, and 63 Project Scoping Plan
Minimum Sample Quantity Calculations

Survey Unit Type	Nuclide	Estimated Mean (from ESI data or historical data)	Estimated Standard Deviation (from ESI data)	Delta ***	Shift (delta/standard deviation	Pr (from statistical tables)	Total Number of Samples, N **	Number of Samples in each Survey Unit (n)	Number of Samples in each Reference Unit (m)
Environmental Media	Pu-239	NA	0.72	1.25	1.74	0.89	34	17	17
	U-238	0.87	0.33	5.19	15.73	1	21	10	10
	U-235	0.21	0.15	1.75	11.67	1	21	10	10
	Th-230 *	1.56	0.36	3.90	10.83	1	21	10	10
	Ra-226	1.56	0.36	0.52	1.44	0.98	23	11	11
	Pm-147	NA	500	4800	9.60	1	21	10	10
	Cs 137	0.06	0.14	4.80	34.29	1	21	10	10
	Co-60	NA	1	1.98	1.98	0.998	17	17	NA
	Co 57	NA	23.199	77.33	3.33	1	17	17	NA
	H3	NA	82.8	276	3.33	1	21	10	10
Building Surfaces	Am 241	1	1	120.00	120.00	1	21	10	10
	Pu 239	1	1	130.00	130.00	1	21	10	10
	U-235, U-238, and associated decay products except Ra-226 and Th-230	1	1	5,000.00	5,000.00	1	21	10	10
	Ra-226 and Th-230	1	1	1,000.00	1,000.00	1	21	10	10
	Beta-gamma emitters present in background	1000	500	5,000.00	10.00	1	21	10	10
	Beta-gamma emitters not present in background (Cs-137 andH-3)	1000	500	5,000.00	10.00	1	17	17	NA

* estimated from decay product, Ra-226

** $N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{12c(1-c)(P_r - 0.5)^2}$ for datasets that will be compared to reference areas taken from NUREG 1505

$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(p' - 0.5)^2}$ for datasets that will not be compared to reference areas. taken from NUREG 1505

α = Type 1 error rate
β = Type 2 error rate
$Z(1-\alpha/2)$ = Z statistic for Type 1 error rate
$Z(1-\beta)$ = Z statistic for Type 2 error rate
c = proportion of samples to be collected in the reference area
P = specified probability required to detect that a random measurement from the survey unit is larger that a random measurement from the reference area
p' = probability that the sum of two independent random measurements from the survey unit is less than 2*delta

*** Delta is equal to the guideline value, and is expressed in units of pCi/g for environmental media, and in units of dmp/100cm^2 for building surfaces

Type 1 error	0.05	$Z(1-\alpha)$	1.96
Type 2 error	0.05	$Z(1-\beta)$	1.645

Number or units/referenc	1
fraction (c)	50%

APPENDIX H

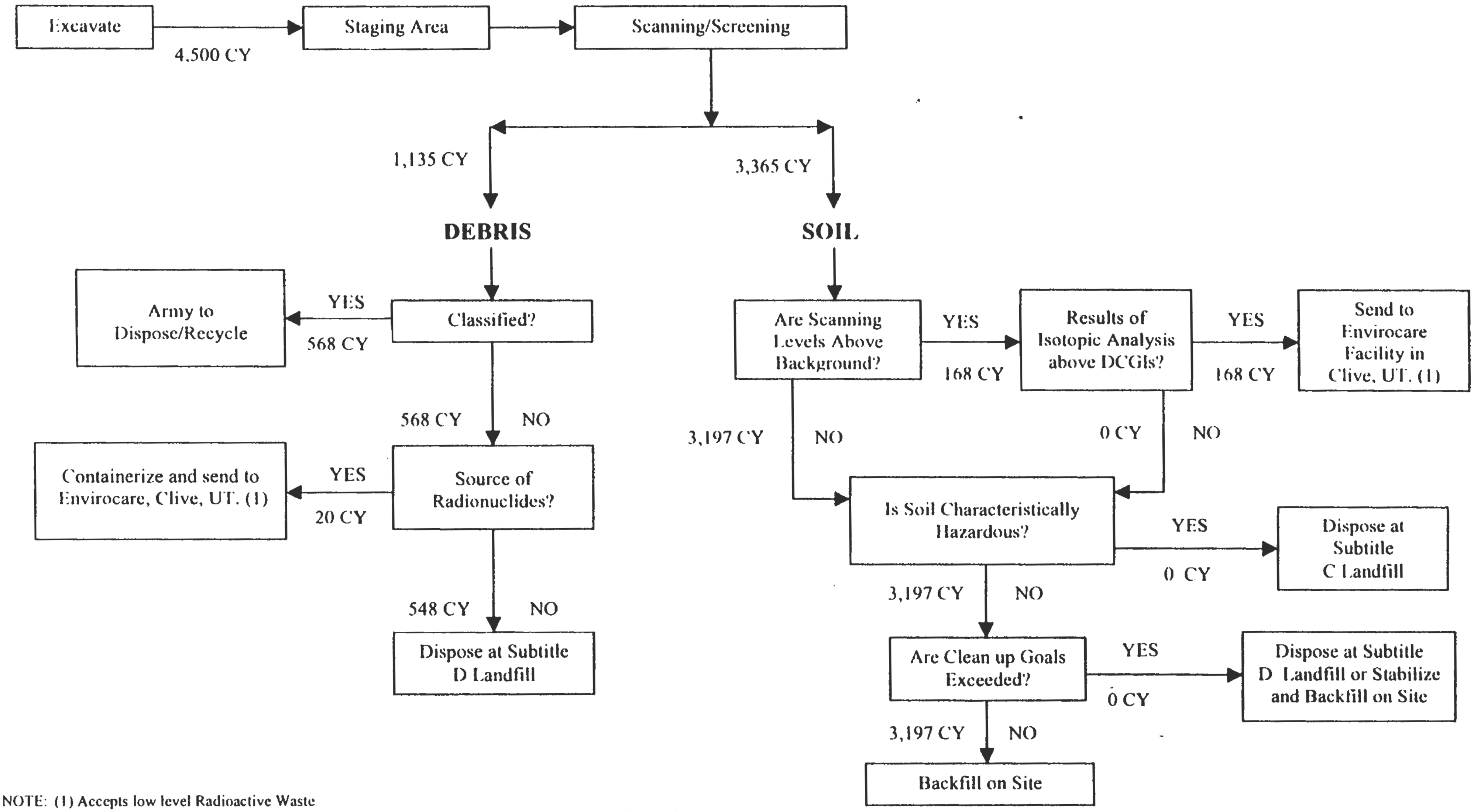
COST ESTIMATE BACK UP

Cost Components	Duration/Unit	Basis
Excavation		
Backhoe	1.5 mos	
Staging/Sorting		
Bermed staging area		
Vibrating Screen	1.5 mos	
Stockpile area for rad soil	168 cy	
Stockpile area for non-rad soil	2007 cy	
Debris stockpile area for classified	568 cy	
Debris stockpile area for non-classified	568 cy	
Debris Disposal		
Disposal of rad debris - Envirocare	20 cy	
Transportation of rad debris - Envirocare	20 cy	
Disposal of Classified Debris (Army)	568 cy	
Transportation of Classified Debris	568 cy	
Disposal of non-rad, non-class debris (Seneca Meadows)	548 cy	
Transportation to Seneca Meadows	548 cy	
Soil Disposal		
Non-rad soil (keep on site)	3197 cy	Balance
Amount of Fill Needed (=quantity of debris)	1135 cy	
Transportation of non-rad soil	0 cy	
Non-rad over TAGM soil - Seneca Meadows or stabilize	0 cy	
Transportation to Seneca Meadows	0 cy	
Disposal of rad soil (Envirocare)	168 cy	
Transporatation of rad soil (Envirocare)	168 cy	
Extraction of GW		
Installation of 4 wells to be used as mw		
Frac tanks	140000 gal	
Pumps	4	
Analytical		
Confirmatory soil samples	20	
GW sampling	11	7 wells x 4 QA/QC samples
Frac tank sampling	14	assume 21,000 gall tanks - 7 tank fulls x 2 samples each tank full.
Soil Pile sampling	17	1 per 200 cy/ - round up to 25
TCLP	12	

Total Quantity	4500 cy
Quantity of soil	3365 cy
100 lbs/cu.ft.	
1.35 tons/cy	4543 tons
Amount of debris	1135 cy
200 lbs/cu. ft	
2.7 tons/cy	3064.5 tons

Assume 5% soil elevated rad levels
Assume 50% classified parts

DISPOSAL DECISION FLOW CHART
SEAD-63 DECISION EVALUATION/COST ANALYSIS
SENECA ARMY DEPOT ACTIVITY, ROMULUS, N.Y.



NOTE: (1) Accepts low level Radioactive Waste
Volumes are used in the cost estimate and are estimated based on test pit logs and data collected during the ESI.

R:\SENECA\RIFS\SEAD64A\DDFC-64A.DOC

PARSONS ENGINEERING SCIENCE, INC. **PARSONS**

CLIENT ____ JOB. NO. ____ SHEET 1 OF 3
SUBJECT Test Pits - Calculate volume of Debris BY JMT DATE ____
CKD. ____ REVISION ____

Test Pit TP63-1
Pit Dimensions: 20' × 4.5' × 8' = 720 CF

Debris - 2'-8' 6' × 20' × 4.5' = 540 CF

TP63-2
Pit Dimensions: 3' × 3' × 5.5' = 50 CF

No Debris.

TP63-3
Pit Dimensions: 13' × 8' × 9.2' = 957 CF

Debris 1'(?) × 13' × 8' = 104 CF

TP63-4
Pit Dimensions: 12' × 3' × 6.5' = 234 CF

Debris: 5' × 3' × 12' = 180 CF

TP63-5
Pit Dimensions: 17' × 3' × 5' = 255 CF
Debris = 0

TP63-6

Pit Dimensions: 39' × 3' × 8' = 936 CF

Debris: 1 Drum.

TP63-7
Pit Dimensions: 11' × 10' × 8' = 880 CF

Debris: 1.5' × 11' × 10' = 165 CF

PARSONS ENGINEERING SCIENCE, INC. PARSONS

CLIENT ______ JOB. NO. ______ SHEET 2 OF 3
SUBJECT ______ BY ______ DATE ______
CKD. ______ REVISION ______

TP63-8

Pit Dimensions: 13.25' × 3' × 5.25' = 209CF

Debris: None

TP63-9 Pit Dimensions: 14.5' × 3' × 8' = 348CF

Debris: None

TP63-10 Pit Dimensions: 12' × 3' × 5.3' = 191CF

Debris: None

TP63-11 Pit Dimensions: 14' × 5.75' × 7.25' = 584CF

Debris: 4' × 14' × 5.75' = 322CF

TP63-12 Pit Dimensions: ~~11' × 10' × 8~~ 5.4' (Depth) × 3' × 10' (est) Length = 162CF

No debris.

1F TOTAL VOL

Total test pit volume: 5526 CF
Total debris volume 1311 CF
% Debris ~24%

CLIENT ______ JOB. NO. ______ SHEET 3 OF 3
SUBJECT ______ BY ______ DATE ______
CKD. ______ REVISION ______

Total test pit volume: 5526 CF

Total debris volume: 1311 CF

% Debris ~ 25%

Total affected volume: 24,500 sq. ft × depth.

Approximate Depth of waste: 3.5' (ave depth)
Based on table in sect 2, max >8'
Say 5'

Volume = 122,500 CF = 4540 cy × 25%

Vol of Debris = 1135 cy

DACW41 98-D-9003

DACW41-97-R-0023-0001

Rates for Envirocare Disposal, Provided by U.S.ACOE (4/16/99).

PROPOSAL SCHEDULE

08 December 1998 - 09 December 1999

Line Item	Description	Unit Price
0001	Bulk soil - licensed surveyor	$ 166.60 /CY
0002	Bulk soil - density/weight	$ 149.50 /CY
0003	Bulk Mixed Waste - density/weight	$ 660.00 /CY
0004	Intermodal soil - licensed surveyor	$ 166.60 /CY
0005	Intermodal soil - density/weight	$ 149.50 /CY
0006	Intermodal Mixed Waste - density/weight	$ 660.00 /CY
0007	Container soil - rated volume	$ 166.60 /CY
0008	Container Mixed Waste - rated volume	$ 720.00 /CY
0009	Debris - density/weight	$ 427.50 /CY
0010	Mixed Waste Debris - density/weight	$ 1397.00/CY
0011	Non-Conforming Waste Handling - Excess Moisture Content	$ 250.00 /CY

Line Item Pricing for optional years will be negotiated prior to exercising option.

Use or disclosure of data contained on this sheet is subject to t restriction on the title page of this proposal or quotation.

SESSLER WRECKING
Division of
L.M. SESSLER EXCAVATING & WRECKING, INC.
1257 NYS ROUTE 96
WATERLOO, NEW YORK 13165
(315) 539-8222 FAX (315) 539-3967

September 29, 1999

TO: Eliza Schacht
Parsons Engineering
FR: Craig Sessler
RE: Seneca Army Depot Estimate

As per our conversation this date, Sessler Wrecking is pleased to provide you with this estimate of services:

LOCATION: Seneca Army Depot, Romulus, NY

ITEM: Screen, Separate, and Stockpile Dirt from C&D Material - Approximately 36,000 cy

PRICE: $20.00/cy

Said estimate includes all equipment, supervision, labor, insurance as necessary to perform the above referenced work.

If we can be of further assistance to you in this matter, please give us a call.

* No UXO involved..!

OFFICE COPY

SALES QUOTATION

B.R. DEWITT, INC. ("Seller")
6895 Ellicott Street
Pavilion, New York 14525
Telephone: (716) 584-3132 • Fax: (716) 584-3466

8508

DATE: 9-23-99

CUSTOMER: ("Buyer") PARSONS ENGINEERING SCIENCE

CONTACT: ANNA FODOR

PHONE: (781)401-2178

FAX: (781)401-2575

PROJECT OR JOB NAME: CLEAN FILL

DELIVERY LOCATION: SENECA ARMY DEPOT, ROMULUS, NEW YORK
SENECA COUNTY

Is this Project or Job Sales Tax Exempt: Yes____ NO____ If yes, please enclose your Exemption Certificate.

We are pleased to quote you as follows:

QUANTITY:	**DESCRIPTION:**	**UNIT PRICE:**
MATERIAL:		F.O.B. BURDETT
	BANK SAND	$1.50/TON
		DELIVERED TO JOB
	BANK SAND	$4.35/TON
****	FLOWABLE FILL (50 - 150 PSI) NYSDOT ITEM #17502.9503	$13.00/YD.

FIBERS ______ per
SATURDAY DELIVERY ______ per
HEAT ______ per

PROVISIONS
Including Those Which Appear on the Reverse Side

1. **Time of Delivery.** Regularly scheduled operating hours 7:00 a.m. to 4:00 p.m. Monday through Friday during the appropriate season.
2. **Expiration of Quotation.** This Quotation will be open only for thirty (30) days from the date of this quotation.
3. **Contract.** This Quotation shall not result in a Contract until it is accepted and acknowledged by Seller at Seller's office in Pavilion, New York.
4. **Expiration of Contract.** A Contract for the sale and/or delivery of materials at the place, price and in the quantity stated is effective only during the dates indicated.

CONTRACT EFFECTIVE: 9-23-99
CONTRACT EXPIRES: 4-1-00

Respectfully Submitted,
B.R. DEWITT, INC.
BY:
KEVIN KESSLER SALES REP.

TERMS OF PAYMENT: NET 30 DAYS

SPECIAL INSTRUCTIONS:

QUOTATION ACCEPTED

BUYER:
BY:
ITS:

SELLER: **B.R. DEWITT, INC.**
BY:
ITS:

SUMMARY REPORTS SUMMARY PAGE

DETAILED ESTIMATE DETAIL PAGE

33. Remedial Action
- 01. Mobilize and Preparatory Work

- 04. Temporary Utilities

- 02. Sampling, & Testing

- 03. Site Work

- 19. Transportation and Disposal

- 20. Site Restoration

- 26. Demobilization

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

SEAD-63
Miscellaneous Components Burial Site/Excavation and Off-Site Disposal

Designed By: Parsons ES
Estimated By: Parsons ES

Prepared By: Jackie Travers

Preparation Date: 03/23/99
Effective Date of Pricing: 10/03/96
Est Construction Time: 100 Days

Sales Tax: 7.0%

MCACES for Windows
Software Copyright (c) 1985-1997
by Building Systems Design, Inc.
Release 1.2

EQUIP ID: NAT97C Currency in DOLLARS

PROJECT BREAKDOWN:

The estimate is structured as follows and uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined. The detail items are at LEVEL 6.

LEVEL 1 - WBS Level 1 (Account)
LEVEL 2 - WBS Level 2 (System)
LEVEL 3 - WBS Level 3 (Subsystem)
LEVEL 4 - User Defined (Assembly Category or Other)
LEVEL 5 - User Defined (Assembly or Other)

PROJECT DESCRIPTION:
The scope of work is presented by contractor. There will be two contractors on this project. Prime contractor AA will be responsible for all on-site activities except for treatment/scanning of rad waste. Treatment of rad waste will be done by prime contractor AB.

The scope of work for both the contractors is summarized below.

The following is a summary of the activities that are presently included in the prime contractor AA's scope of work:

- Layout the areas to be excavated,
- Excavation, shoring, and screening of non rad soil,
- Removal of debris and soil from excavation,
- Stormwater management at the excavations, at the soil screening operation, and at the soil stockpiles,
- Discharge of non rad groundwater
- Disposal of the screened material including scrap metal, stone, sod, etc.,
- Backfilling the excavation with the clean, off-site borrow,
- Sampling, lab analysis, collection of samples,
- Load non-rad waste into containers, and
- All permits for work.

The following activities are included in the prime contractor AB's scope of work:

- Perform rad scanning

Treat rad contaminated groundwater
Disposal of rad soil and debris

PRODUCTIVITY:

Productivity, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. When required, productivity for appropriate activities will be adjusted for this project as follows:

1. Level of Protection A - Productivity ___%
2. Level of Protection B - Productivity ___%
3. Level of Protection C - Productivity ___%
4. Level of Protection D - Productivity 85%.

All activities are conducted in Level of Protection D.

The following daily time breakdown was assumed.

	Level A	Level B	Level C	Level D
Availiable Time (minutes)	480	480	480	480
Non-Productive Time (minutes):				
Safety meetings	20	20	10	10
Suit-up/off	60	60	40	10
Air tank change	160	20	0	0
*Breaks	60	60	40	30
Cleanup/decontamination	20	20	20	20
Productive Time (minutes)	160	300	370	410
Productivity:	160/480 X100%	300/480 X100%	370/480 X100%	410/480 X100%
	33%	63%	77%	85%
Example:				
Normal Production Rate (CY/HR)	250	250	250	250
X Productivity	.33	.63	.77	.85
=Reduced Production Rate(CY/HR)	83	158	193	213
* Break time ranges (minutes)	60-140	60-140	40-140	30-70

The following list the areas where there is the biggest potential for changes in cost due to uncertainties:

- Quantities of soil to be stabilized could increase based on the results of the confirmatory sampling done in the excavation.

Contractor costs are calculated as a percentage of running total as

10.0 % for field office support
5.0 % for home office support
6.4 % for profit
4.0 % for bond

Owner's cost are calculated as a percentage of running total as
5.0 % for design contingency
5.0 % for escalation
12.0 % for construction contingency
3.5 % for other costs
8.0 % for construction management

OTHER GOVERNMENT COSTS:

Other Government Costs consist of:

*Engineering and Design During Construction (EDC)	1.0%
As-Builts	0.5%
Operation and Maintenance (O&M) Manuals	0.5%
Laboratory Quality Assurance	1.0%

Total, use	3.5%

33.01. Mobilize and Preparatory Work	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST

33. Remedial Action

The RA consists of removal of 5 ft of soil over an area of 24,500 ft2 (4,500 yd3) for sorting and off-site disposal of contaminated soil and all debris.

33.01. Mobilize and Preparatory Work

Remedial Action consists of excavating soils in area of disposal pits in sections, screening and sorting each section, and taking confirmatory sample from bottom of each section. After screening and confirmatory sampling, uncontaminated soil may be backfilled

	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
33.01.01. Mob Construction Equip & Fac									
USR AA Mobilization of equipment and personnel - earthmoving	1.00	LS	0	1,500	2,000	535	0	4,035	4035.00
USR AB Mobilization of equipment and personnel - haz waste	1.00	LS	0	1,500	2,000	535	0	4,035	4035.00
USR AA Field Office Trailer	1.50	MOS	0	0	1,500	0	0	1,500	1000.00
USR AA Toilet Portable Chemical	1.50	MO	0	0	0	161	0	161	107.00
33.01.02. Contractor Oversight									
USR AA Project Managers	480.00	HR	0	15,468	0	0	0	15,468	32.23
FOP AA Contract Administrators	120.00	HR	120	3,115	0	0	0	3,115	25.95
RAD AA Site Safety & Health Officer	480.00	HR	480	26,280	0	0	0	26,280	54.75
USR AA Surveyors	0.50	MON	0	0	0	2,140	0	2,140	4280.00
33.01.03. Preconstruc Submittals/Impl Plan									
B USR AA Work Plan	420.00	HR	0	33,600	0	0	0	33,600	80.00
33.01.04. Temporary Utilities									
TOTAL Phone	1.50	MO	0	0	0	300	0	300	200.00
TOTAL Temporary power	1.00	EA	0	0	0	1,000	0	1,000	1000.00
TOTAL Bottled water	1.50	MO	0	0	0	300	0	300	200.00
TOTAL Construction fence , 6 ft chain	1400.00	LF	0	1,372	14	8,400	0	9,786	6.99

33.02. Sampling, & Testing

The soil analysis consists of TAL metals, VOCs, SVOCs, PCBs, TCLP metals, and gamma/alpha spec every 200 cu. yd. of excavated soil (23 samples) plus 20 confirmatory samples (gamma/alpha spec, and metals only) to confirm extent of removal.

GW analysis is one sample per well (4 new plus 3 existing) plus 4 QA/QC one time for VOCs, SVOCs, Pest/PCBs, metals, and rad (total 11) plus 14 samples on water collected during excavation.

	33.02. Sampling, & Testing	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
	33.02.03. Air Monitoring & Sampling The only air monitoring that is included is fugitive dust air monitoring at the excavation and rad montoring.									
USR AA	Digital Dust Sampler (Monthly Rental)	2.00	EA	0	0	0	1,621	0	1,621	810.53
USR AA	Ambient Air Monitor (Monthly Rental)	2.00	EA	0	0	0	3,345	0	3,345	1672.41
USR AB	Micro-R, Gas Prop detector, Gas Prop floor detector, Fidler	10.00	WK	0	0	6,650	0	0	6,650	665.00
	33.02.04. Monitoring Wells The estimate allows for four new monitoring wells. Each well is assumed to be 15 feet deep.									
AFH AA	Testing, ground water, monitor well sampling eqpt rental	10.00	DAY	0	0	0	375	0	375	37.45
HTW AA	Monitor well, casing, 2" dia, 10' L, PVC sched 40, flush threaded	60.00	LF	5	135	37	70	0	242	4.03
USR AA	4-1/4" ID x 8" OD For 2" Or Less Casing/Screen	60.00	LF	52	724	1,583	0	0	2,307	38.45
USR AA	Split Spoon Sample, 2" x 24" During Drilling	20.00	EA	0	0	0	535	0	535	26.75
USR AA	2" Dia Filter Sock	16.00	LF	1	11	23	9	0	43	[illegible] 70
USR AA	4" Expandable Locking Cap With stainless Steel Bolt	4.00	EA	7	95	207	100	0	402	1
USR AA	No. 2 Morie Silica Sand - Contaminant Free	0.50	TON	4	55	121	185	0	361	721.54
USR AA	Bentonite Grout - 50# Bags	4.00	EA	0	0	0	107	0	107	26.66
AF AA	Well, domestic water, standby, drill rig	10.00	HR	30	843	947	0	0	1,790	179.02
	33.02.05. Sample / analyze Grndwtr Water from the excavations will be pumped into tanks and will be tested before it is discharged back to the ground. If the groundwater needs to be treated it will be treated on site. Each tank of wastewater will be tested for TAL metals and gross alpha/beta plus gamma/alpha spec. The estimated number of samples is based on using 7-20.000 gallon frack tank-fulls with two samples per tank full (14). Groundwater monitoring costs are included in this estimate. Seven (four new and 3 existing) wells will be sampled intially for gross alpha/beta, gamma and alpha spectrometry, TAL/TCL. Long term monitoring costs (beyond the first year of operation) are facility operating/maintenanceand have not been included. Unit costs marked up 200% for quick turnaround on a portion of the samples from frac tanks (8 out of 14).									
HTW AA	Testing, misc sample collection (shallow), daily rate, subcontracted	5.00	EA	0	0	0	0	3,167	3,167	633.33

33.02. Sampling, & Testing	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
AFH AA Testing, misc sample collection (shallow), car or van mileage charge	300.00 MI	0	0	0	148	0	148	0.49
AFH AA Testing, misc sample collection (shallow), personnel per diem	5.00 DAY	0	0	0	388	0	388	77.58
HTW AA Testing, packaging & shipping, 32 oz HDPE bottle, 12/case	5.00 EA	0	0	0	181	0	181	36.10
HTW AA Testing, packaging & shipping, custody seals (package of 10)	5.00 EA	0	0	0	79	0	79	15.75
HTW AA Testing,packaging & shipping, 1gal,4/case,safe trans càn w/vermiculite	17.00 EA	0	0	0	497	0	497	29.21
HTW AA Testing, packaging & shipping, 51# to 70# pkg, overnight dlvy service	20.00 EA	0	0	0	0	1,565	1,565	78.27
AFH AA Testing, LAS, S&SA, TAL metals (6010/7000s).	17.00 EA	0	0	0	0	3,273	3,273	192.50
RAD AA Testing, LAS,plutonium-isotopic , radn analy liquid, alpha spectroscopy	17.00 EA	0	0	0	0	2,550	2,550	150.00
RAD AA Testing, LAS, radium-226, 228, radn analy liquid, alpha spectroscopy	17.00 EA	0	0	0	0	2,833	2,833	166.67
RAD AA Testing, LAS, thorium isotopic, radn analy liquid, alpha spectroscopy	17.00 EA	0	0	0	0	2,238	2,238	131.67
RAD AA Testing, LAS, uranium isotopic, radn analy liquid, alpha spectroscopy	17.00 EA	0	0	0	0	2,238	2,238	131.67
RAD AA Testing, LAS, tritium(dir cnt), radn analy liquid, scintillation	17.00 EA	0	0	0	0	1,148	1,148	67.50
USR AA Testing, LAS, gross alpha beta susp or dislvd, radn analy liq,	17.00 EA	0	0	0	0	1,360	1,360	80.00

33.02.09. Laboratory Chemical Anaysis -soi

Includes all laboratory analysis cost for the soil sampling (20 confirmatory and 23 soil pile samples (1 per 200 cy). 45 day turnaround time. Confirmatory samples analyzed for radionuclides and TAL metals only.

33.02.09. Laboratory Chemical Anaysis -soi	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
HTW AA Testing, LAS, HW RCRA eval, TCL P - total list	12.00 EA	0	0	0	0	18,000	18,000	1500.00
AFH AA Testing, LAS, S&SA, semivolatil e organics (8270)	25.00 EA	0	0	0	0	11,417	11,417	456.67
AFH AA Testing, LAS, S&SA, TAL metals (6010/7000s).	45.00 EA	0	0	0	0	8,663	8,663	192.50
RAD AA Testing, LAS, americium isotopic, radn analy veg/sed/soil, alpha	45.00 EA	0	0	0	0	6,300	6,300	140.00

	33.02. Sampling, & Testing	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT
RAD AA	Testing, LAS, plutonium isotopic, radn analy veg/sed/soil, alpha	45.00	EA	0	0	0	0	6,450	6,450	143.33
RAD AA	Testing, LAS, thorium isotopic, radn analy veg/sed/soil, alpha	45.00	EA	0	0	0	0	6,300	6,300	140.00
RAD AA	Testing, LAS,gross beta-tot, radn analy veg/sed/soil,gas flow prop cnt	45.00	EA	0	0	0	0	2,250	2,250	50.00
RAD AA	Testing, LAS, radium-226, 228, radn analy veg/sed/soil, gamma spect	45.00	EA	0	0	0	0	5,550	5,550	123.33
RAD AA	Testing, LAS, uranium-total, radn analy veg/sed/soil, gamma spect	45.00	EA	0	0	0	0	3,038	3,038	67.50
RAD AA	Testing, LAS, liquid scintillation, tritium, radn analy veg/sed/soil	45.00	EA	0	0	0	0	2,700	2,700	60.00

33.03. Site Work

33.03.02. Clearing and Grubbing

Site work includes excavation of soils, and placement of fill in 12 inch lifts into the excavated area. Erosion control consists of silt fencing, plastic laminate cover and water truck for dust control . SEAD-63 area to be excavated is 24,500 sq. ft.

		QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT
AF AA	Clearing, brush w/dozer & brush rake, light brush	0.50	ACR	1	23	33	0	0	56	111.86
MIL AA	Clearing, wheel & ramp load spoils, 2 mi haul to dump	10.00	CY	10	257	88	0	0	345	34.50

33.03.03. Earth work

Fill material = 24,500sf * 5 ft = 122,500 total cf. Assume 29,403 cf to remain on site, therefore need 93,097 cf fill

		QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT
USR AA	Clean Fill, DeWitt Quote (includes transport)	1135.00	CY	0	0	0	10,663	0	10,663	9.39
MIL AA	Excavate & load, hydr excavator , 3/4 CY, wet matl	4500.00	CY	194	6,075	3,420	0	0	9,495	2.11
MIL AA	Excavate & load, hydr excavator , 2 CY, wet matl	4500.00	CY	90	2,835	4,050	0	0	6,885	1.53
AF AA	Fill, spread borrow w/dozer	4500.00	CY	54	1,530	2,835	0	0	4,365	0.97
USR AA	Screen, separate, stockpile dirt from debris - Sessler	4500.00	CY	0	0	0	0	90,000	90,000	20.00

33.03. Site Work		QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
	33.03.11. Erosion control									
MIL AA	TRK,WTR,OF-HY, 5000GAL,W/CAT613 C (2mosx20 daysx10 hrs)	400.00	HR	0	0	13,408	0	0	13,408	33.52
HTW AA	LGLCS, fugitive dust, 250 lb tear str, synth cov waste pile, plstc lam	10000	SF	9	200	0	3,959	0	4,159	0.42
HTW AA	LGLCS, fugitive dust, add for metal grommets, synth cov waste pile	500.00	EA	0	0	0	332	0	332	0.66
MIL AA	Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	1400.00	LF	64	1,624	0	345	0	1,969	1.41
	33.06. Groundwater Collection The only groundwater to be collected is the groundwater from the areas that are excavated. This water must be tested prior to release for radionuclides and metals. It is assumed that some treatment will be necessary.									
USR AA	21,000 Gallon (500Bbl), Steel, Open, Stationary, Monthly (3	2.00	EA	0	0	0	2,696	0	2,696	1348.20
MIL	Dewatering, sump hole, incl excavation & gravel, pit	1500.00	CF	29	780	120	899	0	1,799	1.20
AF	Pump, propylene body, 40' hd, housing & impeller, 22 GPM, 1/3 HP	4.00	EA	6	240	0	2,080	0	2,320	580.10
	33.09. Treatment of Groundwater									
	33.19. Transportation and Disposal Assume no haz waste. Assume 3000 cy debris and 8000 cy soil.									
	33.19.02. Non Hazardous Waste 20 cy Debris to Envirocare; 170 cy rad soil to Envirocare; 2700 cy debris and soil to Seneca Meadows; 1100 cy soil to remain on site. 570CY classified debris - Army to dispose. Drums to be repackaged.									
	33.19.03. Low Level Radioactive Waste									
USR AB	Radioactive Bulk Soil Disposal (Envirocare) - rad soil	168.00	CY	0	0	0	0	25,116	25,116	149.50
USR AB	Disposal of containerized rad waste - Envirocare	20.00	CY	0	0	0	0	8,550	8,550	427.50
AFH	HTRW, dispose hazardous waste, box car, rail car transportation	1080.00	CWT	0	0	0	3,467	0	3,467	3.21
AFH	HTRW, dispose hazardous waste, box car, rail car transportation	4536.00	CWT	0	0	0	14,561	0	14,561	3.21

33.20. Site Restoration	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
33.20. Site Restoration									
33.20.09. Post-Construction Maintenance									
AF AA Watering, water by truck	126.00	MSF	2	53	89	3	0	145	1.15
TOTAL Site debris cleanup and removal	0.50	AC	0	42	40	0	0	83	165.04
33.20.16. Remove fencing (019422002)									
MIL AA Site dml, chain link fence, remove & salvage for reuse	1400.00	LF	72	1,820	0	0	0	1,820	1.30
33.26. Demobilization									
33.26.11. Final Decontamination									
USR AA Site Debris Clean-Up & Removal	1.00	AC	13	170	175	0	0	345	344.72
USR AB Site Debris Clean-Up & Removal	1.00	AC	13	170	176	0	0	346	345.61
TOTAL Demob of Equip/Facl	1.00	EA	0	0	0	5,000	0	5,000	5000.00
TOTAL Demob Of Personnel	1.00	EA	0	0	0	5,000	0	5,000	5000.00
TOTAL Removal Report	1.00	EA	0	25,000	0	0	0	25,000	25000.00
TOTAL Removal Of Temp. Fac.	1.00	EA	0	0	0	5,000	0	5,000	5000.00
TOTAL SEAD-63			1,256	125,517	39,517	75,011	214,705	454,749	

Tri-Service Automated Cost Engineering System (TRACES)
PROJECT S63DS3: SEAD-63 - Miscellaneous Components Burial
SEAD-63 Off-site Disposal of Debris/Contam Soil
** PROJECT OWNER SUMMARY - SUBSYSTM (Rounded to 10's) **

		QUANTY UOM	CONTRACT	DES CONT	ESCALATN	CONTINGN	OTHER	CON MGMT	TOTAL COST	UNIT COST
33	Remedial Action									
33.01	Mobilize and Prepara									
33.01.01	Mob Construction	1.00 EA	12,440	620	650	1,650	540	1,270	17,170	17165.36
33.01.02	Contractor Oversi	1.00 EA	60,070	3,000	3,150	7,950	2,600	6,140	82,920	82916.40
33.01.03	Preconstruc Submi	1.00 EA	42,940	2,150	2,250	5,680	1,860	4,390	59,270	59273.01
33.01.04	Temporary Utiliti	1.00 EA	14,550	730	760	1,930	630	1,490	20,090	20085.79
	TOTAL Mobilize and Prep	1.00 EA	130,000	6,500	6,830	17,200	5,620	13,290	179,440	179440.55
33.02	Sampling, & Testing									
33.02.03	Air Monitoring &	1.00 EA	14,850	740	780	1,960	640	1,520	20,490	20491.30
33.02.04	Monitoring Wells	1.00 EA	7,870	390	410	1,040	340	800	10,870	10867.18
33.02.05	Sample / analyze	1.00 EA	27,690	1,380	1,450	3,660	1,200	2,830	38,220	38216.28
33.02.09	Laboratory Chemic	1.00 EA	90,320	4,520	4,740	11,950	3,900	9,230	124,660	124661.10
	TOTAL Sampling, & Testi	1.00 EA	140,720	7,040	7,390	18,620	6,080	14,390	194,240	194235.85
33.03	Site Work									
33.03.02	Clearing and Grub	1.00 ACR	510	30	30	70	20	50	710	707.27
33.03.03	Earth work	1.00 CY	155,170	7,760	8,150	20,530	6,710	15,860	214,170	214172.90
33.03.11	Erosion control	1.00 LF	25,390	1,270	1,330	3,360	1,100	2,600	35,050	35047.71
	TOTAL Site Work	1.00 EA	181,070	9,050	9,510	23,960	7,830	18,510	249,930	249927.88
33.06	Groundwater Collecti	1.00 EA	7,570	380	400	1,000	330	770	10,440	10442.22
33.09	Treatment of Groundw									
33.19	Transportation and D									
33.19.03	Low Level Radioac		61,060	0	3,050	7,690	2,510	5,950	80,260	
	TOTAL Transportation an	1.00 EA	61,060	0	3,050	7,690	2,510	5,950	80,260	80258.92
33.20	Site Restoration									
33.20.09	Post-Construction	0.50 ACR	190	10	10	20	10	20	260	511.85
33.20.11	Site debris clean	0.50 AC	110	0	10	10	0	10	140	277.28
33.20.16	Remove fencing		2,330	0	120	290	100	230	3,060	
	TOTAL Site Restoration	1.00 EA	2,620	10	130	330	110	260	3,450	3452.30

	QUANTY UOM	CONTRACT	DES CONT	ESCALATN	CONTINGN	OTHER	CON MGMT	TOTAL COST	UNIT COST
33.26 Demobilization									
33.26.11 Final Decontamina	1.00 EA	880	40	50	120	40	90	1,220	1217.79
33.26.12 Demob of Equip/Fa	1.00 EA	6,390	0	320	810	260	620	8,400	8400.37
33.26.20 Demob Of Personne	1.00 EA	6,390	320	340	850	280	650	8,820	8820.39
33.26.22 Removal Report	1.00 EA	31,950	1,600	1,680	4,230	1,380	3,270	44,100	44101.94
33.26.31 Removal Of Temp.	1.00 EA	6,390	320	340	850	280	650	8,820	8820.39
TOTAL Demobilization	1.00 EA	52,010	2,280	2,710	6,840	2,230	5,290	71,360	71360.87
TOTAL Remedial Action	1.00 EA	575,050	25,260	30,020	75,640	24,710	58,450	789,120	789118.60

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R2029:                SEAD-63                No Unit Price Database - No Division Summary, Reprice, or UPB Titles
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* * * END OF ERROR REPORT * * *

ENVIROCARE RADIOACTIVE MATERIAL LICENSE

DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF RADIATION CONTROL

Michael O. Leavitt
Governor
Dianne R. Nielson, Ph.D.
Executive Director
William J. Sinclair
Director

168 North 1950 West
P.O. Box 144850
Salt Lake City, Utah 84114-4850
(801) 536-4250 Voice
(801) 533-4097 Fax
(801) 536-4414 T.D.D.

Received
1-21-99
LB

JAN 1999
RECEIVED

January 19, 1998

Mark Ledoux, Corporate Radiation Safety Officer
Envirocare of Utah, Inc.
46 West Broadway, Suite 240
Salt Lake City, Utah 84101

RE: Radioactive Material License No. UT2300249, Amendment Request Dated January 15, 1999

Dear Mr. Ledoux:

The Division of Radiation Control has reviewed the information submitted for the proposed license amendment. Based on the information, the Envirocare license has been amended as follows:

- Condition 59. The Licensee shall fulfill and maintain compliance with all conditions and requirements as contained in the LARW Waste Management Plan, dated July 9, 1998.

This amendment has been designated Amendment Number #02. If you have any questions or concerns about this letter or the amendment, you may contact us at (801) 536-4250.

Sincerely,

Craig W Jones Acting for
William J. Sinclair, Director
Division of Radiation Control

Enclosure

cc: Greg Copeland, Envirocare of Utah, Inc.
Myron Bateman, E.H.S., M.P.A., Health Officer
Tooele County Health Department

RENEWAL

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF RADIATION CONTROL
RADIOACTIVE MATERIAL LICENSE

Pursuant to Utah Code Ann. Title 19. Chapter 3 and the Radiation Control Rules. Utah Administrative Code (UAC) R313. and in reliance on statements and representations heretofore made by the licensee designated below. a license is hereby issued authorizing such licensee to transfer. receive. possess. and use the radioactive material designated below: and to use such radioactive material for the purpose(s) and at the place(s) designated below. The license is subject to all applicable rules. and orders now or hereafter in effect and to all conditions specified below.

* * *

LICENSEE		3. License Number UT 2300249 Amendment # 02
1. Name	Envirocare of Utah. Inc.	
2. Address	46 West Broadway Suite 240 Salt Lake City. UT 84101	4. Expiration Date October 22. 2003
		5. License Category 4-a

* * *

6. Radioactive Material (element and mass number)		7. Chemical and/or physical form	8. Average concentration per container on receipt	
A1.	Americium-241	A1. through AAA inclusive. Notwithstanding Conditions 9 (authorized use). 16 (prohibitions). 52 (debris size). and 55 (containerized waste). typically large volume (greater than 1000 cubic feet). bulky or containerized. soil or debris (as defined in Condition 56). Debris can include both decommissioning (cleanup) and routinely generated operational waste including but not limited to radiologically contaminated paper. piping. rocks. glass. metal. concrete. wood. bricks. resins. sludges. tailings. slag. residues. personal protective equipment (PPE) that conforms to the size limitations in Condition 52.	A1.	1.0E04 pCi/g

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6. Radioactive Material (element and mass number)		7. Chemical and/or physical form	8. Average concentration per container on receipt	
A2	Americium-243		A2.	1.0E04 pCi/g
B1.	Antimony-124		B1	4.4E08 pCi/g
B2.	Antimony-125		B2.	4.4E08 pCi/g
C.	Barium-133		C.	1.0E05 pCi/g
D.	Beryllium-7		D.	4.4E08 pCi/g
E.	Bismuth-207		E.	5.0E04 pCi/g
F.	Cadmium-109		F.	4.4E08 pCi/g*
G.	Calcium-45		G.	4.4E08 pCi/g
H.	Carbon-14		H.	5.0E05 pCi/g
I1.	Cerium-139		I1.	4.4E08 pCi/g
I2.	Cerium-141		I2.	4.4E08 pCi/g
I3.	Cerium-144		I3.	4.4E08 pCi/g*
J1.	Cesium-134		J1.	4.4E08 pCi/g
J2.	Cesium-135		J2.	4.4E08 pCi/g
J3.	Cesium-137		J3.	6.0E04 pCi/g*

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6. Radioactive Material (element and mass number)		7. Chemical and or physical form	8. Average concentration per container on receipt	
K.	Chromium-51		K.	4.4E08 pCi/g
L1.	Cobalt-56		L1.	4.4E08 pCi/g
L2.	Cobalt-57		L2.	4.4E08 pCi/g
L3.	Cobalt-58		L3.	4.4E08 pCi/g
L4.	Cobalt-60		L4.	3.0E04 pCi/g
M.	Copper-67		M.	4.4E08 pCi/g
N1.	Curium-242		N1.	2.0E06 pCi/g
N2.	Curium-243		N2.	1.0E04 pCi/g
N3.	Curium-244		N3.	1.0E04 pCi/g
O1.	Europium-152		O1.	2.0E04 pCi/g
O2.	Europium-154		O2.	3.0E04 pCi/g
O3.	Europium-155		O3.	4.4E08 pCi/g
P.	Gadolinium-153		P.	4.4E08 pCi/g
Q.	Germanium-68		Q.	4.4E08 pCi/g*
R.	Gold-195		R.	4.4E08 pCi/g

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6. Radioactive Material (element and mass number)		7. Chemical and/or physical form	8. Average concentration per container on receipt	
S.	Hafnium-181		S.	4.4E08 pCi/g
T.	Hydrogen-3 (Tritium)		T	2.5E07 pCi/g
U1.	Iodine-125		U1.	4.4E08 pCi/g
U2.	Iodine-129		U2.	3.1E03 pCi/g
V.	Iridium-192		V.	4.4E08 pCi/g
W1.	Iron-55		W1.	4.4E08 pCi/g
W2.	Iron-59		W2.	4.4E08 pCi/g
X.	Lead-210		X.	2.0E06 pCi/g*
Y.	Manganese-54		Y.	4.4E08 pCi/g
Z.	Mercury-203		Z.	4.4E08 pCi/g
AA.	Neptunium-237		AA.	1.0E04 pCi/g**
BB1.	Nickel-59		BB1.	1.4E07 pCi/g
BB2.	Nickel-63		BB2.	2.2E06 pCi/g
CC.	Niobium-94		CC.	1.3E04 pCi/g
DD1.	Plutonium-238		DD1.	1.0E04 pCi/g

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6 Radioactive Material (element and mass number)	7 Chemical and/or physical form	8 Average concentration per container on receipt
DD2. Plutonium-239		DD2. 1.0E04 pCi/g
DD3. Plutonium-240		DD3. 1.0E04 pCi/g
DD4. Plutonium-241		DD4. 3.5E05 pCi/g
DD5. Plutonium-242		DD5. 1.0E04 pCi/g
EE. Polonium-210		EE. 4.4E08 pCi/g
FF. Potassium-40		FF. 1.0E04 pCi/g
GG. Promethium-147		GG. 4.4E08 pCi/g*
HH1. Radium-226		HH1. 1.0E04 pCi/g*
HH2. Radium-228		HH2. 1.0E04 pCi/g
II. Rubidium-83		II. 4.4E08 pCi/g
JJ. Ruthenium-106		JJ. 4.4E08 pCi/g*
KK Samarium- 151		KK. 4.0E06 pCi/g
LL. Scandium-46		LL. 4.4E08 pCi/g
MM. Selenium-75		MM. 4.4E08 pCi/g
NN. Silver-108m		NN. 5.0E04 pCi/g

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6. Radioactive Material (element and mass number)		7. Chemical and/or physical form	8. Average concentration per container on receipt	
OO.	Silver-110m		OO.	4.4E08 pCi/g
PP.	Sodium-22		PP.	4.4E08 pCi/g
QQ1.	Strontium-85		QQ1.	4.4E08 pCi/g
QQ2.	Strontium-89		QQ2.	4.4E08 pCi/g
QQ3.	Strontium-90		QQ3.	2.5E04 pCi/g*
RR.	Sulfur-35		RR.	4.4E08 pCi/g
SS	Tantalum-182		SS.	4.4E08 pCi/g
TT.	Technetium-99		TT.	1.9E05 pCi/g
UU.	Thallium-204		UU.	4.4E08 pCi/g
VV1.	Thorium-230		VV1.	1.5E05 pCi/g
VV2.	Thorium-232		VV2.	1.0E04 pCi/g*
WW.	Tin-113		WW.	4.4E08 pCi/g
XX1.	Uranium-233		XX1.	5.0E02 pCi/g
XX2.	Uranium-234		XX2.	3.7E05 pCi/g
XX3.	Uranium-235		XX3.	1.7E03 pCi/g

UTAH DIVISION OF RADIATION CONTROL
RADIOACTIVE MATERIAL LICENSE
SUPPLEMENTARY SHEET

License # UT 2300249
Amendment # 02

6. Radioactive Material (element and mass number)	7. Chemical and or physical form	8. Average concentration per container on receipt
XX4. Uranium-236		XX4. 3.8E05 pCi/g
XX5. Uranium-238		XX5. 3.3E05 pCi/g--
XX6. Uranium-natural		XX6. 6.8E05 pCi/g—
XX7. Uranium-depleted		XX7. 3.7E05 pCi/g—
YY1. Yttrium-88		YY1. 4.4E08 pCi/g
YY2. Yttrium-91		YY2. 4.4E08 pCi/g
ZZ Zinc-65		ZZ. 4.4E08 pCi/g
AAA. Zirconium-95		AAA. 4.4E08 pCi/g*

≠ Ra-228 with its decay products present at the times indicated after separation as pure Ra-228.
* Decay products are assumed to be present in concentrations equal to the parent.
— Short-lived decay products ~~at~~ of U-239 (Th-234 and Pa-234) and of Np-237 (Pa-233) are assumed to be present in concentrations equal to the parent.

****

AUTHORIZED USE

9. A. Licensee may receive, store, and dispose by land burial, radioactive material as naturally occurring and accelerator produced material (NARM) and low-level radioactive waste. Prior to receiving an initial, low-level radioactive waste shipment for disposal from a generator, the licensee shall submit to the Executive Secretary, documentation which demonstrates that the low-level radioactive wastes have been approved for export to the licensee. Approval is required from the low-level radioactive waste compact of origin (including the Northwest Compact), or for states unaffiliated with a low-level radioactive waste compact, the state of origin, to the extent a state can exercise such approval.

B. In accordance with Utah Code Annotated 19-3-105, the licensee may not receive Class B or Class C low-level radioactive waste without first submitting a new license application and receiving approval from the Executive Secretary of the Utah Radiation Control Board and also receiving approval from the Governor and the Legislature.

C. The licensee shall fulfill and maintain compliance with all conditions and shall meet all compliance schedules stipulated in the Ground Water Discharge Permit, number UGW 450005, issued by the Executive Secretary of the Utah Water Quality Board

D. Notwithstanding Conditions 6 and 8, the licensee, with prior written approval from the Executive Secretary on a case-by-case basis, may accept radionuclides additional to those listed in Condition 6 if the concentration of the unlisted radionuclide is less than or equal to 500 pCi/g and in the waste form specified by Condition 7.

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CONDITIONS

SITE LOCATION

10. A. The licensee may receive, store and dispose of licensed material only at the licensee's facility located in Section 32 of Township 1 South and Range 11 West, Tooele County, Utah.

B. Section 32, Township 1 South and Range 11 West, Tooele County, Utah, is defined by the following State Plane Coordinates:

Southwest Section Corner:	N 859260.91 feet E 15496336.53 feet
Elevation	4268.76 feet above mean sea level (amsl)
Southeast Section Corner	N 859164.34 feet E 1554919.52 feet
Elevation	4278.80 feet-amsl
Northwest Section Corner	N 864544.60 feet E 1549727.12 feet
Elevation	4272.36 feet-amsl
Northeast Section Corner	N 864447.90 feet E 1555006.52 feet
Elevation	4279.58 feet-amsl

C. The Southwest Section Corner marker of Section 32 shall be the Point of Beginning (POB).

D. The licensee shall cause a survey to be conducted by a Utah licensed land surveyor to identify the section corners of Section 32, Township 1 South, and Range 11 West, Tooele County, Utah (as defined by State Plane Coordinates in condition 10B). Licensee shall place monuments with brass caps at the identified section corner locations. Monuments shall be permanent and constructed in a manner that will protect them from being disturbed

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11. The licensee shall not possess at any time, more than 300,000 cubic yards of radioactive waste material which is not disposed of in accordance with the finished design requirements. This includes all wastes in storage or active processing.

12. Pursuant to UAC R313-12-55(1), the licensee is granted an exemption to UAC R313-25-9, as it relates to land ownership and assumption of ownership.

SPECIAL NUCLEAR MATERIAL

13. A. The maximum quantity of special nuclear material which the licensee may possess, undisposed of at any one time, shall not exceed: 350 grams of U-235, 200 grams of U-233, and 200 grams Pu, or any combination of them in accordance with the following formula:

$$\frac{(\text{Grams U-235})}{350} + \frac{(\text{Grams U-233})}{200} + \frac{(\text{Grams Pu})}{200} < 1$$

B. Notwithstanding license condition 13.C.3, two 12 inch uncompacted lifts of waste containing Special Nuclear Material may be used as "winter blanket" in accordance with the Envirocare letter to the US Nuclear Regulatory Commission, dated, September 22, 1992. Special Nuclear Material contained within these lifts may be excluded from the licensee's Special Nuclear Material possession inventory.

C. Waste conveyed to the disposal facility by truck is in transport as long as the commercial carrier remains in control of the vehicle and waste shipment. Such waste may be excluded from any possession limits by the licensee. Any waste containing Special Nuclear Material, not disposed on the day delivered, shall be considered in possession of the licensee.

MIXED WASTE

14. A. The licensee may receive for treatment, storage, and disposal any radioactive waste as authorized by this license that is also determined to be hazardous (commonly referred to as mixed waste) as permitted by the "Hazardous Waste Plan Approvals" issued and modified by the Executive Secretary, Utah Solid and Hazardous Waste Control Board and "HSWA Permit" issued by the U.S. Environmental Protection Agency.

B. The licensee shall dispose of these wastes in the "mixed waste" disposal embankment only. Characteristic or listed hazardous waste treated at the Envirocare facility shall not be disposed of in the Low Activity Radioactive Waste (LARW) embankment.

SUM OF FRACTIONS

15. A. If a mixture of radionuclides a, b, and c are present in the waste in the concentrations C_a, C_b, and C_c, and if the applicable average waste concentrations from condition 8 of this license are AWC_a, AWC_b, AWC_c, respectively, then the concentration in the waste shall be limited so that the following relationship exists:

$$\frac{C_a}{AWC_a} + \frac{C_b}{AWC_b} + \frac{C_c}{AWC_c} \leq 1$$

B. If a single radionuclide is present in the waste, the average concentration shall not exceed the applicable value found in condition 8 of this license.

PROHIBITIONS.

16 A. Sealed sources as defined in Utah Administrative Code (UAC)R313-12 shall not be accepted for disposal.

B. In accordance with UAC R313-15-1008(2)(a)(v), waste shall not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

C. In accordance with UAC R313-15-1008(2)(a)(vi), waste shall not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste.

D. In accordance with UAC R313-15-1008(2)(a)(vii), waste shall not be pyrophoric.

E. Waste containing untreated biological, pathogenic, or infectious material including radiologically contaminated laboratory research animals is prohibited

F Receipt of liquid radioactive waste is prohibited.

MANAGEMENT OF FREE LIQUIDS

17. Radioactive waste containing free liquid shall be managed in accordance with the license renewal application, dated 16 March 1998, Appendix U.

RADIATION SAFETY.

18. The licensee shall comply with the provisions of UAC R313-18, "Notices, Instructions and Reports to Workers by License or Registrants, Inspections" and UAC R313-15, "Standards for Protection Against Radiation."

19. The licensee may transport licensed material or deliver licensed material to a carrier for transport in accordance with the provisions of UAC R313-19-100, "Transportation."

20. The licensee shall maintain written procedures and make such procedures available at the site location described in condition 10A. The procedures shall incorporate operating instructions and appropriate safety precautions for the work. The employee training program shall include detailed review of the operating procedures applicable to the employee's assignments. The requirement for written procedures shall include establishment of procedures for conduct of the radiation safety and environmental monitoring programs. including analytical procedures and instrument calibration requirements. The licensee's Corporate Radiation Safety Officer shall review and approve written procedures and subsequent changes to the procedures. At least annually, the licensee shall review all procedures to determine their continued applicability.

21. The Corporation Radiation Safety Officer or other qualified individual designated be the Corporate Radiation Safety Officer shall perform and document weekly inspections of the facility and report any findings of noncompliance affecting radiologic safety. Items for inspection. at a minimum. include: operating procedures, license requirements and safety practices.

ROUTINE MONITORING AND CONTAMINATION SURVEYS

22. The licensee shall conduct contamination surveys in accordance with the following table:

Type	Location	Frequency
A. Gamma Radiation Levels	1. Perimeter of Restricted Area(s)	1. Weekly
	2. Office Area (s)	2. Weekly
	3. Lunch/Change Area(s)	3. Weekly
	4. Transport Vehicles	4. Upon vehicle arrival at site and before departure.
	5. Box wash facility	5. Weekly
	6. Box counter facility	6. Weekly
B. Contamination Wipes	1. Eating Area(s)	1. Weekly
	2. Change Area(s)	2. Weekly
	3. Office Areas(s)	3. Weekly
	4. Railcar rollover and control shack	4. Weekly

	5. Equipment/Vehicles	5. Once before release
C. Employee/Personnel	1. Skin & Personal clothing	1. Prior to exiting controlled area
D. Gamma Exposure	1. Administration Bldg.(s)	1. Quarterly
	2. Security Trailer	1. Quarterly
E. Radon Concentration	1. Administration Bldg.(s)	1. Quarterly
	2. Security Trailer	2. Quarterly

23. The licensee shall determine internal exposure of employees under its bioassay program, in accordance with UAC R313-15-204.

24. The licensee shall implement a respiratory protection program that is in accordance with UAC R313-15-703.

25. The licensee shall calibrate air sampling equipment at intervals not to exceed six months.

26. The operational environmental monitoring program shall be conducted in accordance with the license renewal application dated March 16, 1998, Appendix R.

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27. Vehicles, containers, facilities, materials, equipment or other items for unrestricted use, except conveyances (as defined in UAC R313-19-4) used for commercial transport of radioactive waste, material, shall not be released from the licensee's control if contamination exceeds the limits found in Table 27-A.

TABLE 27-A

Nuclide^{a}	Column I Average ^{b,c,f}	Column II Maximum ^{b,d,f}	Column III Removable ^{b,e,f}
U-nat, U-235, U-238, and associated decay products	5,000 dpm alpha/ 100cm^2	15,000 dpm alpha/ 100cm^2	1,000 dpm alpha/ 100cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100cm^2	300 dpm/100cm^2	20 dpm/100cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100cm^2	3,000 dpm/100cm^2	200 dpm/100cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emissions or spontaneous fission) except Sr-90 and other noted above.	5,000 dpm beta, gamma/100cm^2	15,000 dpm beta-gamma/100cm^2	1,000 dpm beta-gamma/100cm^2

a. Where surface contamination on both alpha-and beta-gamma emitting nuclides exists, the limits established for alpha-and beta-gamma emitting nuclides should apply independently.

b. As used in this table, dpm (disintegration's per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c. Measurements of average contamination should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each such object.

d. The maximum contamination level applies to an area of not more than 100 cm^2.

e. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping the area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.
f. The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

REPORTING

28. A quarterly report shall be prepared by the Corporate Radiation Safety Officer for the Company President evaluating employee exposures, effluent releases and environmental data to determine:

    A. If there are any upward trends in personnel exposures for identifiable categories of workers or types of operations or in effluent releases;

    B. If exposures and effluent might be lowered under the concept of maintaining exposures and effluent as low as reasonablely achievable; and

    C. If equipment for exposures and effluent control is being properly used and maintained.

29. The licensee shall submit the following reports to the Executive Secretary:

    A. Specification of the quantity of each of the principal contaminants released to unrestricted areas in liquid and in airborne effluent during the preceding year including the results of the environmental monitoring program by March 31st of each year for the preceding year.

    B An annual summary of the volume and tonnage, radioisotopes and their activities for materials disposed of by March 31st of each year for the preceding year.

    C. A monthly disposal report of NARM, low-level, mixed, and uranium/thorium mill tailings (i.e., 11e. (2) wastes) to include the volume and tonnage in tons, cubic yards, and cubic feet.

D. The weighted average concentration of no radionuclide contained in waste actually disposed at the facility shall exceed those stated in the License Renewal Application of March 16. 1998. Appendix P. Table 5. The licensee shall submit in writing on a quarterly basis to the Executive Secretary, a report that compares the actual radioactivity received and disposed of with the Weighted Average Concentrations provided in the License Renewal Application of March 16. 1998. Appendix P. Table 5.

30. Except as provided by this condition. the licensee shall maintain the results of sampling. analyses. surveys. and instrument calibration. reports on inspections and audits. employee training records as well as any related reviews. investigations and corrective actions. for five (5) years. The licensee shall maintain personnel exposure records in accordance with UAC R313-15-201.

STAFFING/QUALIFICATIONS

31. Radiation Safety operations shall be conducted by or under the supervision of Mark Ledoux. Corporate Radiation Safety Officer. or other individuals assigned by the Corporate Radiation Safety Officer upon successful completion of the licensee's training program.

32. The licensee's staff shall meet the qualifications as described in the license renewal application dated March 16. 1998. Appendix I.

CONSTRUCTION ACTIVITIES

33. The licensee shall obtain prior written approval from the Executive Secretary prior to construction of significant facilities. Significant facilities shall include, but are not limited to waste. stormwater. and wastewater related handling, storage, and transfer projects.

34. Prior to construction of any liner or radon barrier. the licensee shall submit a revision to the currently approved Construction Quality Assurance/Quality Control (CQA/QC) manual to the Executive Secretary for approval. The revision shall include the procedures. equipment. and field forms for sealed single ring infiltrometer testing.

35. The licensee shall construct any clay liner or radon barrier in accordance with the test pad procedures that have been approved by the Executive Secretary. The testing of any clay liner or radon barrier shall be performed using the same methods and equipment (8 inch radius sealed ring infiltrometer) as used on the test pad.

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A. The licensee shall construct a test pad for any clay liner or radon barrier whenever there is a change in any of the following:

1. Liner or radon barrier specifications.
2. Unified Soil Classification.
3. Construction procedures.
4. Construction equipment.
5. Construction supervisory personnel.
6. Material testing and procedures. or
7. When more than a year has passed since the last placement of clay liner or radon barrier.

B. The licensee shall provide a plan to the Executive Secretary for review and approval detailing the proposed changes in any clay liner or radon barrier construction. This plan shall be submitted to Executive Secretary prior to test pad construction.

C. The licensee shall give Division of Radiation Control (DRC) notice 48 hours in advance of commencement of test pad construction in order that DRC may observe all phases of test pad construction.

D. The licensee shall provide a report to Executive Secretary. for review and approval. detailing the successful test pad results prior to implementing changes in any clay liner or radon barrier construction. This report shall be certified by a Utah registered professional engineer.

36. The licensee shall conduct permeability testing of the Type B Filter Layer in accordance with ASTM-D2434 to demonstrate a minimum permeability of 3.5 cm/sec. The testing shall be performed at a rate of one test per 5.000 cubic feet of Type B Filter material. Furthermore. the licensee shall conduct a study demonstration that at a certain specified gradation. the minimum permeability specification of 3.5 cm/sec will always be maintained. The testing procedures may be changed to the gradation testing frequency specified in the currently approved CQA/QC manual upon approval of the demonstration study by the Executive Secretary.

37. A. The licensee shall place a freeze/thaw barrier in accordance with Drawing Number 9407-4, Revision N, dated June 15, 1998. The freeze/thaw layer shall have a residual water content of at least 3.5% weight percent and the following gradation:

1. D100<=3/4 inch
2. D85>=No. 4 sieve (4.75 mm)
3. D50>=No. 20 sieve (0.85 mm)
4. D15>=No. 100 sieve (0.150 mm)

B. The licensee shall perform residual water content testing using ASTM methods D-3152 (at 15 ATM) and D-2325 and gradation testing using ASTM method C-136 at a range of one test per 2000 cubic feet. However, the licensee may conduct a study demonstrating that at certain specified gradation, the minimum residual water content specification of 3.5 percent by weight will always be maintained. Testing procedures may be changed to gradation testing and rates specified in the currently approved CQA/QC manual upon approval of the licensee's demonstration study by the Executive Secretary.

38. The licensee shall provide a long term settlement plan to the Executive Secretary for review and approval by January 15, 1999.

39. Prior to construction of the cover system on the west side of the LARW cell, the licensee shall submit and obtain approval from the Executive Secretary for final detailed engineering design and specifications of a transition zone between the new and former LARW cover design.

40. Disposal of mobile waste shall be restricted to the topslope area of the LARW cell, as limited by State Plane coordinates in Table 40-A. Any waste lift containing any mobile waste shall be designated as mobile waste lifts and shall be disposed of within the mobile waste boundaries.

Table 40-A

Table 40-A. Boundaries of Mobile Waste Disposal and LARW Cell Topslope Design	State Plane Coordinates (ft)	
	Northing	Easting
LARW Cell Waste Disposal Boundaries		
Northeast Corner	861,161	1,553,660
Southeast Corner	859,489	1,553,625
Southwest Corner	859,509	1,552,510
Northwest Corner	861,181	1,552,544
Mobile Waste Disposal Boundaries		
Northeast Corner	860,991	1,553,490
Southeast Corner	859,669	1,553,445
Southwest Corner	859,689	1,552,690
Northwest Corner	861,011	1,552,714
LARW Topslope Cover Design Boundaries (Envirocare Drawing 9407-4, Rev 1, 2/18/98		
Northeast Corner	861,011	1,553,510
Southeast Corner	859,649	1,553,465
Southwest Corner	859,669	1,552,670
Northwest Corner	861,031	1,552,694

41. The LARW Cell topslope shall be constructed in accordance with all engineering design and specifications approved by this license, and as restricted to the State Plane Coordinates, provided in Table 40-A.

42. "Mobile wastes" shall be defined as any waste containing any quantity of the following isotopes: carbon-14, iodine-129, neptunium-237, sodium-22, technetium-99, and tritium.

43. The clay liner shall be placed on foundation which has been excavated and prepared to the lines, grades and dimensions prescribed in the approved plans. The first lift may be placed in an uncompacted lift not to exceed twelve inches (12"). All subsequent lifts shall be placed in lifts not to exceed an uncompacted thickness of nine inches (9"). Each lift shall be compacted to not less than ninety-five percent (95%) optimum density as determined by ASTM D-698 and field permeability tests as specified in the currently approved Engineering Drawings.

44. The licensee shall fulfill all requirements and maintain compliance with all conditions in the currently approved CQA/QC manual and currently approved Engineering Drawings.

45. The disposal cell liner and radon barrier shall be constructed with a moisture content range of optimum moisture content to plus five percent (+5%) of optimum moisture as determined by Standard Proctor Method ASTM D-698.

46. The licensee shall compact the radon barrier to not less than 95 percent of maximum dry density as determined by Standard Proctor Method ASTM D-698 and a field permeability as specified in the currently approved Engineering Drawings.

47. The licensee shall not initiate disposal operations in newly excavated areas until the DRC has inspected and the Executive Secretary has approved the cell/embankment liner.

CONSTRUCTION DRAWINGS.

48. A. The licensee shall provide a comprehensive set of drawings for the entire Clive site. The drawings shall correctly: (1) locate all structures, utilities, fences, ponds, drainage features railroad tracks, roads, storage facilities, loading and off-loading facilities, disposal embankments, all environmental monitoring locations including instruments/devices, and any other appurtenances related to the operation, maintenance and closure of the disposal facility; and (2) provide structural details including site elevation. A directory shall be included that identifies

drawings by discrete number, title, date and revision. The drawings shall indicate as-built conditions as they existed no earlier than 30 days prior to the submittal. Drawings of finished construction shall be marked as "As-Built."

B. Drawings showing approved future designs, shall be marked as "Record Drawings." Record drawings or construction drawings shall be certified by a Utah registered professional engineer.

C. Within 30 days of the completion of any project that requires approval by the Executive Secretary, a set of "As-Built" drawings shall be submitted for review and inclusion into the comprehensive drawing set.

SITE OPERATING PROCEDURES

49. The licensee shall place radioactive waste in lifts with an uncompacted thickness not exceeding twelve inches (12").

50. In-place radioactive waste shall be compacted at a moisture content up to three percent (3%) above optimum as determined by the Standard Proctor Method ASTM D-698.

51. The licensee shall compact each lift to not less than ninety percent (90%) of optimum density as determined by Standard Proctor Method ASTM D-698. Sampling points for compaction testing shall include locations immediately adjacent to debris when debris is included in the lift.

52. All debris shall be less than ten inches (10") in at least one (1) dimension, and no longer than eight feet (8') in any dimension.

53. The final twenty-four inches (24") of the radioactive waste embankment, within the side slopes and the top surfaces, shall be free of debris. In addition, no debris shall be placed within twenty-four inches (24") of the clay liner.

54. A lift or any portion of a lift shall be limited to less than ten percent (10%) by volume of debris and the debris shall be uniformly distributed throughout the lift. However, debris in the form of concrete, stone or metal may be placed in the lift, up to twenty-five percent (25%) by volume of the total lift, uniformly distributed throughout, and the debris ~~is~~ placed to minimize void space in the lift.

55. A. Notwithstanding Condition 52. the licensee may accept for disposal. oversized debris in the form of the following filled containers:

1. B-25 boxes (96 cubic feet capacity)
2. B-12 boxes (48 cubic feet capacity)
3. Standard drums of at least 50 gallons
4. Over-pack drums
5. Other monolithic forms similar in size and shape to those listed in Condition 55.A.1 through 55.A.4.

The contents of these containers shall have been initially formed as a single substantial monolithic unit. and the bulk density of the contents in the containers shall be at least 70 pounds per cubic foot. Such oversized debris shall be managed and disposed of in accordance with the currently approved "Oversized Debris Placement Plan" and currently approved "CQA/QC manual."

B For other non-conforming oversized debris. the licensee shall request authorization from the Executive Secretary for disposal on a case by case basis.

56. For the purpose of this license. "debris" is defined as any radioactive waste for disposal other than soils. "Compactible soil" is defined as: (A) having a graded material that will pass through a four inch (4") grizzly. and (B) as having a bulk density greater than seventy pounds per cubic foot dry weight in accordance with ASTM D-698.

57. The licensee shall record. at the time of acceptance. the date and time of day that any lift or portion of a lift that has been approved as finished by the licensee in accordance with all specifications and license conditions.

58 The licensee shall fulfill and maintain compliance with all conditions and requirements in the Waste Characterization Plan as contained in the license renewal application. dated 16 March 1998. Appendix T.

59. The licensee shall fulfill and maintain compliance with all conditions and requirements as contained in the LARW Waste Management Plan. dated July 9. 1998.

60. All wind dispersed litter. located outside of the disposal cell/embankments. shall be retrieved by the licensee and returned to the licensee's control within 24 hours

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61. Truck, railcar, and other equipment washdown (decontamination) facilities, including evaporation ponds, shall be controlled with fences or other approved barriers to prevent intrusion.

62. All burial embankments and waste storage areas, including immediately adjacent drainage structures, shall be controlled areas, surrounded by a six foot (6') high, chain link fence. All permanent fences shall be chain link, six feet (6') high, topped with three strand barbed wire, top tension wire and twisted selvedge.

63. Radioactive and mixed waste within any restricted area is possessed by the licensee.

64. "Disposal" is the locating of radioactive waste into a lift of the disposal embankment. Disposal does not include the storage of waste in containers on a lift when the container will ultimately be emptied, the staging of containerized waste in the disposal embankment; or waste as "winter blanket."

MANIFEST/SHIPPING REQUIREMENTS

65. The licensee shall comply with UAC R313-15-1006 and UAC R313-25-33(8), Requirements for Low-Level Waste Transfer for Disposal at Land Disposal Facilities and Manifests.

66. The licensee shall not accept radioactive waste for storage and disposal unless the licensee has received from the shipper a completed manifest that complies with UAC R313-15-1006 and UAC R313-25-33(8).

67. The licensee shall maintain copies of complete manifests or equivalent documentation required under Conditions 63 and 64 until the Executive Secretary authorizes their disposition.

68. The licensee shall immediately notify the Division of Radiation Control or the Division's on-site representative of any waste shipment where there may be a possible violation of applicable rules or license conditions.

69. The licensee shall require anyone who transfers radioactive waste to the facility to comply with the requirements in UAC R313-15-1006.

70. The licensee shall acknowledge receipt of the waste within one (1) week of waste receipt by returning a signed copy of the manifest or equivalent document to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the licensee. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received.

71. The licensee shall notify the shipper (e.g., the generator, the collector, or processor) and the Division of Radiation Control when any shipment or part of a shipment has not arrived within 60 days after the advance manifest was received.

72. Licensee shall maintain a record for each shipment of waste disposed of at the site. At a minimum, the record shall include:
    A. The date of disposal of the waste;
    B. The location of the waste in the disposal site;
    C. The condition of the waste packages received;
    D. Any discrepancy between the waste listed on the shipment manifest or shipping papers and the waste received in the shipment;
    E. A description of any evidence of leaking or damaged packages or radiation or contamination in excess of applicable regulatory limits; and
    F. A description of any repackaging of wastes in any shipment.

FINANCIAL ASSURANCE/CLOSURE

73. The licensee shall maintain a Surety (Trust) Agreement that satisfies the requirements of UAC R313-25-31 in an amount adequate to fund the decommissioning and reclamation of licensees' grounds, equipment and facilities by an independent contractor. The licensee shall annually review the amount of surety under the Surety (Trust) Agreement and submit a report of its findings to the Executive Secretary by August 31 each year. The Executive Secretary shall annually determine the required amount of surety under the Surety (Trust) Agreement and shall require the licensee to adjust the surety as necessary to reflect any increase in decommissioning and reclamation costs.

74. One (1) year prior to the anticipated closure of the site, the licensee shall submit for review and approval by the Executive Secretary a site decontamination and decommissioning plan. As part of this plan, the licensee shall demonstrate by measurements and/or modeling that concentrations of radioactive materials which may be released to the general environment, after site closure, will not result in an annual dose exceeding 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public.

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75. In accordance with UAC R313-25-33(6), the licensee shall submit a financial statement annually by March 31st of each year for the previous year.

76. Notwithstanding Conditions 8DD2, 8DD4, and 8XX3, the concentration in any lift shall not exceed 1.0E03 pCi/gram for Pu-239, 3.5E03 pCi/gram for Pu-241, and 7.7E02 pCi/gram for U-235.

77. Except as specifically provided otherwise ~~by~~ in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Utah Radiation Control Rules, Utah Administrative Code R313 shall govern unless the statements, representations, and procedures in the licensee's application and correspondence are more restrictive than the rules.

A. License renewal application, revision 6, dated 16 March 1998.
B. Letter dated October 23, 1998
C. Letter dated January 15, 1999

UTAH RADIATION CONTROL BOARD

William J. Sinclair

William J. Sinclair, Executive Secretary

1-19-99

Date

SEAD-63
Miscellaneous Components Burial
Site/Excavation and Off-Site
Disposal - O&M

Designed By: Parsons ES
Estimated By: Parsons ES

Prepared By: Jackie Travers

Preparation Date: 03/23/99
Effective Date of Pricing: 10/03/96
Est Construction Time: 100 Days

Sales Tax: 7.0%

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MCACES for Windows

Release 1.2

EQUIP ID: NAT97C Currency in DOLLARS

PROJECT BREAKDOWN:

The estimate is structured as follows and uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined. The detail items are at LEVEL 6.

LEVEL 1 - WBS Level 1 (Account)
LEVEL 2 - WBS Level 2 (System)
LEVEL 3 - WBS Level 3 (Subsystem)
LEVEL 4 - User Defined (Assembly Category or Other)
LEVEL 5 - User Defined (Assembly or Other)

PROJECT DESCRIPTION:
O&M Costs for Annual Groundwater Sampling

PRODUCTIVITY:

Productivity, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. When required, productivity for appropriate activities will be adjusted for this project as follows:

1. Level of Protection A - Productivity ___%
2. Level of Protection B - Productivity ___%
3. Level of Protection C - Productivity ___%
4. Level of Protection D - Productivity 85%.

All activities are conducted in Level of Protection D.

The following daily time breakdown was assumed.

	Level A	Level B	Level C	Level D
Availiable Time (minutes)	480	480	480	480
Non-Productive Time (minutes):				
Safety meetings	20	20	10	10
Suit-up/off	60	60	40	10
Air tank change	160	20	0	0
*Breaks	60	60	40	30
Cleanup/decontamination	20	20	20	20
Productive Time (minutes)	160	300	370	410

Productivity:	160/480 X100%	300/480 X100%	370/480 X100%	410/480 X100%
	33%	63%	77%	85%

Example:

Normal Production Rate (CY/HR)	250	250	250	250
X Productivity	.33	.63	.77	.85
=Reduced Production Rate(CY/HR)	83	158	193	213
* Break time ranges (minutes)	60-140	60-140	40-140	30-70

The following list the areas where there is the biggest potential for changes in cost due to uncertainties:

Contractor costs are calculated as a percentage of running total as
10.0 % for field office support
5.0 % for home office support
6.4 % for profit
4.0 % for bond

Owner's cost are calculated as a percentage of running total as
5.0 % for design contingency
5.0 % for escalation
12.0 % for construction contingency
3.5 % for other costs
8.0 % for construction management

OTHER GOVERNMENT COSTS:

Other Government Costs consist of:

*Engineering and Design During Construction (EDC)	1.0%
As-Builts	0.5%
Operation and Maintenance (O&M) Manuals	0.5%
Laboratory Quality Assurance	1.0%

Total, use	3.5%

33. O&M - Groundwater Monitoring

O&M Costs consist of Sampling 7 wells and sampling for rad and metals once a year. Sampling report also will be prepared.

33.01. Mobilize and Conduct Sampling

Mobilize for one week of field work. Provide technicians and management for sampling of 7 wells

33.01. Mobilize and Conduct Sampling	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
33.01.01. Mob Construction Equip & Fac									
USR AA Field Office Trailer	0.25	MOS	0	0	250	0	0	250	1000.00
USR AA Toilet Portable Chemical	0.25	MO	0	0	0	27	0	27	107.00
33.01.02. Contractor Oversight									
USR AA Project Managers	8.00	HR	0	258	0	0	0	258	32.23
USR AA Field Technician	80.00	HR	0	1,600	0	0	0	1,600	20.00
FOP AA Contract Administrators	8.00	HR	8	208	0	0	0	208	25.95
RAD AA Site Safety & Health Officer	8.00	HR	8	438	0	0	0	438	54.75
33.01.04. Temporary Utilities									
TOTAL Phone	0.25	MO	0	0	0	50	0	50	200.00
TOTAL Bottled water	0.25	MO	0	0	0	50	0	50	200.00

33.02. Sampling, & Testing

Sample 7 wells for rad and metals.

33.02.05. Sample / analyze Grndwtr	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT COST
AFH AA Testing, misc sample collection (shallow), car or van mileage charge	300.00	MI	0	0	0	148	0	148	0.49
AFH AA Testing, misc sample collection (shallow), personnel per diem	5.00	DAY	0	0	0	388	0	388	77.58
HTW AA Testing, packaging & shipping, 32 oz HDPE bottle, 12/case	1.00	EA	0	0	0	36	0	36	36.10
HTW AA Testing, packaging & shipping, custody seals (package of 10)	1.00	EA	0	0	0	16	0	16	15.75
HTW AA Testing,packaging & shipping, 1gal,4/case,safe trans can w/vermiculite	11.00	EA	0	0	0	321	0	321	29.21
HTW AA Testing, packaging & shipping, 51# to 70# pkg, overnight dlvy service	2.00	EA	0	0	0	0	157	157	78.27
AFH AA Testing, LAS, S&SA, TAL metals (6010/7000s).	11.00	EA	0	0	0	0	2,118	2,118	192.50

33.02. Sampling, & Testing	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	SUBCONTR	TOTAL COST	UNIT
RAD AA Testing, LAS,plutonium-isotopic , radn analy liquid, alpha spectroscopy	11.00	EA	0	0	0	0	1,650	1,650	150.00
RAD AA Testing, LAS, radium-226, 228, radn analy liquid, alpha spectroscopy	11.00	EA	0	0	0	0	1,833	1,833	166.67
RAD AA Testing, LAS, thorium isotopic, radn analy liquid, alpha spectroscopy	11.00	EA	0	0	0	0	1,448	1,448	131.67
RAD AA Testing, LAS, uranium isotopic, radn analy liquid, alpha spectroscopy	11.00	EA	0	0	0	0	1,448	1,448	131.67
RAD AA Testing, LAS, tritium(dir cnt), radn analy liquid, scintillation	11.00	EA	0	0	0	0	743	743	67.50
USR AA Testing, LAS, gross alpha beta susp or dislvd, radn analy liq,	11.00	EA	0	0	0	0	880	880	80.00
33.26. Demobilization and Report Prep									
TOTAL Sampling Report	1.00	EA	0	5,000	0	0	0	5,000	5000.00
TOTAL SEAD-63			16	7,503	250	1,035	10,277	19,066	

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Thu 21 Oct 1999              Tri-Service Automated Cost Engineering System (TRACES)                    TIME 13:31:45
Eff. Date  10/03/96         PROJECT S630&M:   SEAD-63 - Miscellaneous Components Burial
                                                 SEAD-63 O&M Costs                                   SUMMARY PAGE    1
                           ** PROJECT OWNER SUMMARY - SUBSYSTM (Rounded to 10's) **

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                                 QUANTY UOM   CONTRACT  DES CONT  ESCALATN  CONTINGN     OTHER  CON MGMT  TOTAL COST    UNIT COST
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33  O&M - Groundwater Monit

33.01  Mobilize and Conduct

33.01.01  Mob Construction      1.00 EA        350        20        20        50        20        40         490       488.21
33.01.02  Contractor Oversi     1.00 EA      3,200       160       170       420       140       330       4,420      4416.26
33.01.04  Temporary Utiliti     1.00 EA        130        10        10        20        10        10         180       176.41
                                           ----------- --------- --------- --------- --------- --------- -----------
    TOTAL Mobilize and Cond     1.00 EA      3,680       180       190       490       160       380       5,080      5080.87


33.02  Sampling, & Testing

33.02.05  Sample / analyze      1.00 EA     14,300       710       750     1,890       620     1,460      19,730     19731.84
                                           ----------- --------- --------- --------- --------- --------- -----------
    TOTAL Sampling, & Testi     1.00 EA     14,300       710       750     1,890       620     1,460      19,730     19731.84


33.26  Demobilization and R

33.26.22  Sampling Report       1.00 EA      6,390       320       340       850       280       650       8,820      8820.39
                                           ----------- --------- --------- --------- --------- --------- -----------
    TOTAL Demobilization an     1.00 EA      6,390       320       340       850       280       650       8,820      8820.39
                                           ----------- --------- --------- --------- --------- --------- -----------
    TOTAL O&M - Groundwater     1.00 EA     24,370     1,220     1,280     3,220     1,050     2,490      33,630     33633.10
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R2029:              SEAD-63              No Unit Price Database - No Division Summary, Reprice, or UPB Titles

                                  * * *   END OF ERROR REPORT   * * *
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No Backup Reports...

* * * END TABLE OF CONTENTS * * *

SUMMARY REPORTS SUMMARY PAGE

DETAILED ESTIMATE DETAIL PAGE

33. O&M - Groundwater Monitoring
    01. Mobilize and Conduct Sampling

        04. Temporary Utilities

    02. Sampling, & Testing

    26. Demobilization and Report Prep

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

Response to the Comments From the U.S. Environmental Protection Agency, Region II

Subject: Action Memorandum for the Miscellaneous Components Burial Site (SEAD-63)
Seneca Army Depot, Romulus, New York, dated July, 2001

Comments Dated: August 23, 2001

Date of Comment Response: October 31, 2001

USEPA REGION II:

1. Comment: Section 2.1, 2nd ¶, 2nd to last Sentence: This statement seems outdated.

   Response: We believe the comment refers to the sentence "The depot formerly employed approximately 1,000 civilian and military personnel." This sentence is valid. No change has been made to the text

2. Comment: Section 5.1.9, 1st Sentence: Replace the word remedial with removal.

   Response: The word remedial has been replaced with removal.

3. Comment: An exposure frequency of 14 days for SEAD-63 is not protective of public health. EPA proposed an exposure frequency based on 3 days/week during 13 summer weeks, and 1 day/week for the remaining 39 weeks of the year for a total exposure frequency of 78 days/year.

   Response: EPA's recommended exposure frequency as stated above has been considered for a recreational visitor (child). The recommended exposure frequency was directly used for exposure to soil, groundwater, and sediment. For exposure to surface water, we assumed wading events take place every time during 13 spring visits (when water is most likely to accumulate in the ditches) and 10% of other visits. Therefore, an exposure frequency of 20 days/yr was used for exposure to ditch water and sediment. This is a very conservative assumption because the ditch is usually dry except during storm periods. In addition, we used other conservative assumptions such as half of the total body surface being exposed during the wading event. The comparison of the human health risks presented in this report with the previously calculated risks are summarized in the attached table.

   All the risks calculated for the recreational child, park worker, and construction worker are within EPA's target risk ranges (i.e., 10^{-4} to 10^{-6} for lifetime cancer risk and 1 for non-cancer hazard risk) and therefore, are acceptable. The recreational child resulted in a hazard index of 0.4 and a cancer risk of 8E-5. The park worker resulted in a hazard index of 0.2 and a cancer risk of 5E-5. The primary constituents driving the cancer risk are dibenz(a,h)anthracene and benzo(a)pyrene in surface water. These two constituents were detected in only one sample out of 22 samples. Therefore, risk driven by these two constituents is most likely lower than indicated by the mini-risk assessment. In addition, the sediment of the ditch where dibenz(a,h)anthracene and benzo(a)pyrene were detected in the surface water is proposed to be excavated. Therefore, risks associated with the surface water due to the compounds will be addressed by the removal action.

In addition to addressing EPA's comments, we have updated our risk assessment of the dermal exposure route according to the USEPA's Dermal Risk Assessment Interim Guidance (1999), which represents the current knowledge of dermal risk assessment. The following major changes were included:

(1) We have updated soil dermal absorption factor according to the USEPA 1999 guidance. Risks associated with semivolatile organic compounds have been added to the risk evaluation by using a default value of 0.1 as the dermal absorption factor.

(2) The dermal RfD or cancer slope factor has been updated according to the USEPA's recommendations (1999).

(3) The permeability coefficient for compounds in water (Kp) and lag time per event (τ) have been updated.

(4) The RME values for soil and water dermal contact (e.g., skin surface area, soil adherence factor) have been updated according to the 1999 guidance.

We have also added residential risk evaluation backup calculations in Appendix F and updated table references in Table 2-15. The residential risk scenario was performed for comparison purposes only and was presented in the text of the earlier versions of this document.

Table 1, attached, compares the risk values in the July 2001 report and the updated risk values provided in this final version.

TABLE 1
Summary of Total Noncarcinogenic and Carcinogenic Risks
SEAD-63
Seneca Army Depot Activity

RECEPTOR	EXPOSURE ROUTE	Total Noncarcinogenic and Carcinogenic Risks			
		July, 2001 Report		October, 2001 Report	
		HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
PARK WORKER	Inhalation of Dust in Ambient Air	7E-07	1E-09	7E-07	1E-09
	Ingestion of Soil	1E-03	5E-08	1E-03	5E-08
	Dermal Contact to Soil	4E-03	NQ	4E-04	8E-08
	Ingestion of Groundwater	1E-01	NQ	1E-01	NQ
	Dermal Contact to Surface Water	7E-03	9E-05	4E-03	5E-05
	Dermal Contact to Sediment	8E-04	1E-08	1E-03	1E-06
	TOTAL RECEPTOR RISK (Nc & Car)	**2E-01**	**9E-05**	**2E-01**	**5E-05**
RECREATIONAL VISITOR (CHILD)	Inhalation of Dust Ambient Air	3E-07	1E-10	1E-06	5E-10
	Ingestion of Soil	7E-04	8E-09	4E-03	4E-08
	Dermal Contact to Soil	7E-04	NQ	4E-04	2E-08
	Ingestion of Groundwater	5E-02	NQ	3E-01	NQ
	Dermal Contact to Groundwater	4E-03	NQ	5E-02	NQ
	Dermal Contact to Surface Water	3E-02	8E-05	4E-02	8E-05
	Dermal Contact to Sediment	3E-03	1E-08	1E-02	3E-06
	TOTAL RECEPTOR RISK (Nc & Car)	**9E-02**	**8E-05**	**4E-01**	**8E-05**
CONSTRUCTION WORKER	Inhalation of Dust in Ambient Air	9E-05	3E-08	9E-05	3E-08
	Ingestion of Soil	2E-01	4E-08	2E-01	4E-08
	Dermal Contact to Soil	3E-01	NQ	2E-02	1E-08
	TOTAL RECEPTOR RISK (Nc & Car)	**5E-01**	**8E-08**	**3E-01**	**9E-08**

NQ = Not Quantified due to lack of toxicity data

onse to Comments From United States Environmental Protection Agency

: Final Action Memorandum and Engineering Evaluation/Cost Analysis (SEAD-63), Seneca Army Depot, Romulus, New York, July 2000

Comments Dated: March 1, 2001

Date of Comment Response: July 13, 2001

Comments:

n reference to the above subject document dated July 2000. EPA finds that the Army has torily addressed all of our previous comments and deems the document acceptable. However, we below some additional comments for your consideration.

cal Risk Assessment (ERA):

nment: Please indicate whether the soil cleanup goal for cadmium is for surface or subsurface soil.

ponse: The soil clean up goal of 50 mg/kg is for both surface and subsurface soils. This clean up l represents the highest concentration of cadmium that could exist at the site, all other constituents ng present at their current levels, and still result in acceptable human and ecological risk (i.e. <1, carcinogenic risk <1 x 10-4, and EQ<1) for all scenarios. These scenarios include receptors os both surface and subsurface soils (e.g., the construction worker).

mment: All qualifiers such as "small," "significant," and "high" should be removed from the cussions of Hazard Quotients (HQ). Any HQ greater than or equal to one is considered to pose ential ecological risk.

sponse: A review of Appendix F, the Mini-Risk Assessment Documentation, has been performed d qualifiers such as "small", "significant", and "high" have been removed from the discussions of zard Quotients (HQ), unless such qualifiers are in reference to the Menzie et. al. HQ guidelines for essing risk. This guidance uses adjectives such as "significant" and "small" to describe the degree risk potentially associated with various HQ values.

n Risk Assessment (HRA):

mment: Appendix F: It is very difficult to determine the nature and extent of contamination at AD 63 based on the information presented in the mini-risk assessment. A table for each medium ould be provided which includes, at a minimum, the number of samples collected, the range of ected values, and the frequency of detection. This would allow for a more complete assessment of ntamination detected at the site.

sponse: The nature and extent of contamination at SEAD-63 is presented in the A in Section rior to presentation of the mini-risk assessment. Tables 2-3, 2-4, 2-5, 2-6, 2-8, 2-9 and 2-10

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varying scenarios, for example, a nearby resident who may visit the site one time per week during the summer (approximately 14 weeks long).

Response to Comments From New York State Department of Environmental Conservation

Subject: Final Action Memorandum and Engineering Evaluation/Cost Analysis (SEAD-63), Seneca Army Depot, Romulus, New York, July 2000

Comments Dated: January 18, 2001

Date of Comment Response: July 13, 2001

NYSDEC Comments:

1. Comment: The New York State Departments of Health and Environmental Conservation have reviewed the July 2000 Action Memorandum for the Miscellaneous Components burial site (SEAD-63), and offer the following:

(a) As noted in NYSDEC's January 14, 2000 letter on the Draft Action Memorandum, additional comments were pending at that time from the NYSDOH. Unfortunately, those comments were received by NYSDEC during a period of project manager transition, and the NYSDEC failed to forward the NYSDOH comments to SEDA. Please find attached a January 21, 2000 letter from the NYSDOH in which comments are offered on the previous draft of this document. Any efforts that SEDA can make at this time to respond to these comments is appreciated.

(b) It was related some time ago that miscellaneous scrap material sent to local landfills would be surveyed for radiological contamination. If this is still true, please clarify how the surveying will be performed.

(c) Please understand that after SEDA concludes the remediation of this area, NYSDEC and/or the NYSDOH may make confirmatory measurements prior to acceptance of the Final Status Survey. This may contradict an implication of Section 2.7 of the document.

1. Response:

(a) A separate response letter is being prepared to address comments from the NYS Department of Health. We will address these comments as they pertain to the most recently submitted version, the Final Action Memorandum and EE/CA (SEAD-63).

(b) The miscellaneous scrap material that is not considered classified will be sent to a Subtitle D landfill, metal scrap yard, or recycle facility after it has been verified by surveying that there is no radiological contamination. Miscellaneous scrap material and debris will be separated from soil during excavation using a vibratory screen when necessary. Surveying for radioisotopes will be conducted with those instruments used during the building surveys at SEAD-12 to scan the outside of debris.

(c) Text has been added to Section 2.7 stating that the State may make confirmatory measurements of the site prior to acceptance of the Final Status Survey. The Army requests that such measurements be coordinated during the removal action with those taken by the Army to avoid delays in acceptance of the survey.

Response to Comments From New York State Department of Health

Subject: Draft Action Memorandum and Engineering Evaluation/Cost Analysis (SEAD-63).
Seneca Army Depot, Romulus, New York, October 1999

Comments Dated: January 21, 2000

Date of Comment Response: July 13, 2001

Note: These comments were not received by Parsons until Jan 2001 due to changes in PMs at NYSDEC (see NYSDEC comments dated January 18, 2001).

NYSDOH comments:

I have reviewed the October 1999 Action Memorandum for the Miscellaneous Components Burial Site (SEAD-63). Staff of the New York State Department of Health's Bureau of Environmental Radiation Protection have also reviewed the document and provide the following comments:

General Comments:

1. Comment: Based on the results of the samples taken thus far there appears to be little, if any impact from radionuclides at this particular site (SEAD-63), with the possible exception of ground and surface water. As stated in the text, these gross alpha and beta results could easily be influenced by naturally occurring radioisotopes suspended in the water. It would therefore be appropriate, as suggested by the contractor, to re-sample areas where questionable results have been reported. While the RESRAD derived dose: levels for the park workers, recreational child and construction workers are less than the DEC TAGM value of 10 mRem/yr, the final determination on the future use of this land has not been formally accepted by the State. Therefore, other pathways or scenarios such as residential use cannot entirely be ruled out.

1. Response: Residential use at this site is highly unlikely. The community through the Seneca Army Depot Local Redevelopment Authority (LRA), has designated the area within which SEAD-63 lies as a recreation/conservation area. Although the State has not formally accepted this, it is the current intent of the community and the Army.

   As stated in Section 3.3.2 of the EE/CA, radiological levels in soil are not above background. If levels during the excavation are found to exceed background, Derived Concentration Guidelines (DCGLs) have been developed for likely scenarios at the site. For informational and reference purposes, DCGLs have also been developed for a residential scenario in this EE/CA.

Specific Comments:

1. Comment: Page 2-13.2.7 -Contrary to this statement, the New York State Department of Environmental Conservation (NYSDEC) will make confirmatory measurements or review prior to release or acceptance of the Final Status Survey.

1. Response: Text has been added to Section 2.7 stating that the State may make confirmatory measurements of the site prior to acceptance of the Final Status Survey. The Army requests that such measurements be coordinated during the removal action with those taken by the Army to avoid delays in acceptance of the survey.

2. Comment: Page 3-1 Section 3.1, Paragraph 2 – We concur that additional groundwater samples be collected for this site. We also would suggest that the analysis include both a filtered and unfiltered (dissolved vs. suspended portion) analyzed for gross alpha/beta.

2. Response: In an effort to maintain consistency in the sampling technique across the Seneca sites, the Army will collect one unfiltered sample at each groundwater location for analysis. The Army has had numerous conversations with the NYSDEC regarding protocols for minimizing turbidity in groundwater samples collected on site. A low flow sampling technique has been established for collection of groundwater samples on site, and this protocol documented in the Generic RI/FS Project Scoping Plan will be used to collect samples from SEAD-63. The sampling is conducted such that turbidity in a sample is less than 50 NTUs.

3. Comment: Table 5-1 and Page 5-14 -The table 5-1 lists preliminary DCGL's or clean up goals for radionuclides established or derived based on an *"exterior"* dose limit of 10 mREM/yr (pg. 5- 14). Since the TAGM is based on a Total Effective Dose Equivalent, all pathways need inclusion in the calculation, not just EDE. We also note that the RESRAD model doses include inhalation and soil ingestion in the calculations. The numbers listed in Table 5-1 are based only on an external exposure and are therefore not appropriate. In most instances the stated values are far higher than what would be acceptable. We also note that they are preliminary.

3. Response: Table 5-1 has been updated to clarify which pathways were considered for each scenario in the development of DCGLs. External exposure was not the only pathway considered in developing the DCGLs. In compliance with Section III.A.2 an[illegible]II.A.3 of TAGM 4003, current land use and potential use of the site was considered and a [illegible]asonable pathways for each receptor were considered. For the park worker and [illegible]al child, dermal contact to soil, inhalation of dust in ambient air, soil ingestion, an[illegible]ion of

groundwater were considered. For the construction worker scenario, dermal contact to soil, inhalation of dust in ambient air, and soil ingestion were considered.

The DCGLs for a residential scenario were developed for comparison purposes only, as residential use of the SEAD-63 land is highly unlikely and is not currently part of the planned use for this site. Residential DCGLs have been updated in the EE/CA as a result of this comment. The DCGLs derived in the SEAD-12 Remedial Investigation (RI) have been adopted for SEAD-63. We believe these DCGLs are applicable as SEAD-63 is adjacent to the SEAD-12 property and the sites are similar geologically. The residential DCGLs developed in the SEAD-12 RI and adopted for SEAD-63 include the following pathways: Exposure to direct external radiation from photon emitting radionuclides in the soil: inhalation of radionuclides suspended in dust; incidental ingestion of radionuclide contaminated soil: ingestion of radionuclide contaminated groundwater as drinking water; ingestion of contaminated produce grown in contaminated soil: ingestion of contaminated milk and meat taken up by cows grazing on contaminated plants; and radon.

The DCGLs developed in this report are preliminary and will be modified as described in Section 5.3.2 of the Final Action Memorandum.

4. Comment: Table 5-2– The appropriate regulatory document to reference in this table is DEC's 6 NYCRR Part 380. Table II & III. Care should also be taken in the use of these tables since the criteria for release to unrestricted areas is based on a total dose equivalent of 50 mREM to a reference man, if the concentration per isotope were ingested continuously for a year.

4. Response: We believe the comment pertains to Table 5-3 in the final version of the Action Memorandum. The basis for the release criteria described in 6 NYCRR Part 380 has been added as a footnote in the table.

5. Comment: Since Promethium-147 has been detected in soil sediments and surface water, it should be included in establishing clean up levels, although little if any impact to dose will result.

5. Response: A clean up guideline for Pm-147 has been established for the residential scenario using the DCGLs derived in the SEAD-12 RI. This value is 49,350 pCi/g for a resident and has been added to Table 5-1.

APPENDIX I

RESPONSE TO COMMENTS AND AGENCY CORRESPONDENCE

Response to the Department of the Army
U.S. Army Center for Health Promotion and Preventive Medicine
6169 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-6422

Subject: Draft Engineering Evaluation/Cost Analysis Approval Memorandum, Miscellaneous Components Burial Site, SEAD-63, Seneca Army Depot, Romulus, New York, October 1998.

Date Comments Submitted: November 16, 1998

Date of Comment Response: October 18, 1999

Parsons ES General Response: Since the Approval Memorandum was written to provide sufficient information to justify proceeding with the Engineering Evaluation/Cost Analysis (EE/CA) in support of a removal action, and since the agencies involved (i.e. the Army, USEPA, and NYSDEC) have supported the development of the EE/CA for this reason, the Approval Memorandum will not be re-issued. Rather, the responses to these comments below have been incorporated into the EE/CA and the Action Memorandum for this site.

1..Page 2-7, Section 2.4.1, F. Szrom

Comment: This paragraph indicates that "miscellaneous military components- were found in the various test pits. It is unclear if any of the components were tested for or determined to contain radioactive materials, such as radium, which is often found in gauges and dials.

Recommendations: Clarify if the components were tested for or determined to contain radioactive material.

Response: Material excavated from the pits was continuously screened for both organic vapors using an OVM-580B and for radioactivity with a Victoreen-190 alpha-beta-gamma rate meter, a Ludlum-19 micro-R beta and gamma rate meter and a Ludlum 2221 alpha scintillometer. No readings above background levels (0 ppm for the OVM, 10-15 micro Rems per hour for the beta and gamma meters, and 6 counts per minute on the alpha meter) were observed during the excavations. This information is provided in Section 2.6.1.4 of the Engineering Evaluation/Cost Analysis (Appendix A of the Action Memorandum). No material samples of the components were collected for analysis.

2. Page 2-7, Section 2.4.2. Soils, 2nd paragraph, F. Szrom

Comment: This paragraph indicates that a "valid background radionuclide data set is not yet available". Background surveys are typically performed to determine the background radiation exposure levels of radiological parameters and specific radionuclides in the various media. More than one background survey may be required since different geologic materials could be present on-site.

Recommendation: Clarify if one or more background surveys are to be performed.

Response: Background samples were collected and analyzed for radionuclides of concern during the RI activities conducted for SEAD-12. Samples were collected in surface soils, subsurface soils, sediment, surface water and groundwater. These data have been validated and considered in the development of the EE/CA and Action Memorandum. Background statistics are incorporated into the contamination assessment provided in Section 2.6 of the EE/CA. The complete background data set is also presented in Appendix D of the Action Memorandum.

3. Page 2-7, Section 2.4.2, Soils, 2nd paragraph, F. Szrom

Comment: This paragraph indicates that slightly elevated concentrations of Ra-226 were detected. However, Paragraph 2.4 indicates that gross alpha and gross beta were the only radioactivity analyses performed. It is unclear if the gross alpha results were used as an indicator of Ra-226 activity or if specific Ra-226 analyses were performed.

Recommendation: Clarify if the gross alpha results have been used as an indicator of Ra226 activity or if Ra-226 specific analyses were performed. Rewrite Paragraphs 2.4 and 2.4.2 accordingly.

Response: Gross alpha, gross beta, as well as gamma spectral analyses, were performed on the samples collected from SEAD-63 during the ESI. Ra-226 is reported in the gamma spectral analyses. Section 2.4 omitted the mention of gamma spectral analyses. Section 2 of the EE/CA presents all data collected during the ESI, including the gamma spectral analysis results.

4. Page 2-9, Section 2.4.2. Groundwater, Ist paragraph, F. Szrom

Comment: This paragraph indicates that elevated gross beta activity results from the background groundwater monitoring wells (MW63-3 and MW63-1) may be due solely to the high turbidity of the groundwater samples. The paragraph does not discuss the gross alpha activity background groundwater results and therefore, it is assumed that they were not elevated. High turbidity in groundwater samples typically affects both the gross alpha and gross beta activity results.

Recommendation: Clearly state if the gross alpha activity background groundwater results were or were not elevated. If the gross alpha results are not elevated, but the gross beta results are elevated, clarify why the turbidity affects the one analysis and not the other.

Response: The referenced paragraph did not intend to imply that turbidity affects gross beta, but not gross alpha results. Both the background location (MW63-1) and downgradient location (MW63-3) had elevated levels of both gross alpha and gross beta. Section 2.6.4.5 and Table 2-7 of the EE/CA indicate that data from both these wells were above maximum background (i.e. the background developed in support of the SEAD-12 RI) levels for the site. In addition, gross alpha results from both MW63-1 and MW63-2 exceeded the NYS Class GA standard for gross alpha in groundwater (15 pCi/L).

5. Page 2-9, Section 2.4.2. Surface Water, F. Szrom

Comment: According to paragraph, one surface water sample from the four collected may have elevated levels of gross alpha and gross beta activity, however, the "radioactivity results indicate that the surface water as SEAD-63 is not being significantly impacted by radionuclides". The criteria that is being used to determine "significantly impacted" is not clear, since 25% of the samples may contain elevated levels of gross alpha and gross beta activity.

Recommendation: Clarify the criteria used to determine a "significantly impacted" and rewrite the paragraph accordingly.

Response: Since the elevated levels of gross alpha and gross beta in the one surface water sample is possibly attributed to elevated turbidity levels, these levels were not believed to truly indicate a 25% occurrence of elevated gross alpha and gross beta activity.

6. Page 2-9, Section 2.4.2, Surface Water, F. Szrom

Comment: This paragraph indicates that elevated concentrations of potassium-40 (K-40) were detected. However, Paragraph 2.4 indicates that gross alpha and gross beta were the only radioactivity analyses performed. It is unclear if the gross beta results were used as an indicator of K-40 or specific K40 analyses were performed.

Recommendations: Clarify if the gross beta results have been used as an indicator of K40 activity or if K-40 specific analyses were performed. Rewrite Paragraphs 2.4 and 2.4.2 accordingly.

Response: Please see response to Comment No. 3 above.

7. Page 2-10, Section 2.4.2, Sediment, F. Szrom

Comment: No gross alpha or gross beta activity results are reported for the sediment samples. Radiological contamination that is most likely to be present from the operations at SEAD would expect to be particulate in nature. Particulate radionuclide contamination, if released to the soils' surface, most likely will concentrate in sediments over time. Therefore, sediments can be an excellent indicator of background trends and should be sampled and analyzed for elevated levels of gross alpha and gross beta activity.

Recommendation: Clarify if the sediment samples were analyzed for gross alpha and gross beta activities. If the samples were analyzed for radiological parameters, then include a discussion of the results. If the samples were not analyzed for radiological parameters, then plan to do so.

Response: Gross alpha, gross beta, and gamma spectral analyses were performed on the sediment samples collected from SEAD-63. Discussion of this data was inadvertently left out of the Approval Memorandum. However, Section 2.6.6.5 of the EE/CA does discuss the radionuclide results for sediment at SEAD-63.

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NSN 7540-01-317 7368 5099-101 GENERAL SERVICES ADMINISTRATION

Stephen M. Absolom
BRAC Environmental Coordinator
Directorate of Engineering and Housing
Seneca Army Depot Activity (SEDA)
Romulus, New York 14541-5001

Dear Mr. Absolom:

Re: Draft Engineering Evaluation / Cost Analysis (EE/CA) Approval Memorandum, Miscellaneous Components Burial Site (SEAD-63)

This is regarding the above referenced document prepared by Parsons Engineering Science (Parsons ES) for SEDA through the U.S. Army Corps of Engineers New York District and Huntsville Division.

EPA has no objections to the Army preparing a Draft EE/CA for SEAD-63. SEDA has informed us that the non-time critical removal action shall be consistent with the efficient performance of any long-term remedial action, with respect to the release or threatened release concerned. In order that the Army proceeds in the most cost effective manner possible, EPA advises that any alternatives discussed in the EE/CA meet the cleanup objectives for the future land use of SEAD-63, as discussed in the *Reuse Plan and Implementation Strategy for the Seneca Army Depot*.

A facsimile of this letter will be sent to you today. If you have any questions, please call me at (212) 637-4322.

Sincerely yours,

C. Struble

Carla M. Struble, P.E.
Federal Facilities Section

cc: J. Quinn, NYSDEC
D. Geraghty, NYSDOH
R. Scott, NYSDEC-Avon

T. Enroth, USACE-NY
K. Healy, USACE-HD
M. Duchesneau, Parsons ES

New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Eastern Remedial Action, Room 242
50 Wolf Road, Albany, New York 12233-7010
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John P. Cahill
Commissioner

To Steve Absolom	From Jim Quinn
Co./Dept.	Co.
Phone #	Phone # (518) 457-3976
Fax # (607) 869-1362	Fax #

November 5,

Mr. Stephen Absolom
Chief, Engineering and Environmental Division
Seneca Army Depot Activity (SEDA)
5786 State Route 96
Romulus, NY 14541-5001

Fax to:
M. Duchesneau
K. Healy
A. Allen
Tom E.
Mary F.

Dear Mr. Absolom:

Re: SEAD-63
Draft EE/CA Approval Memorandum
Seneca Army Depot, Site ID No. 850006

The New York State Departments of Environmental Conservation (NYSDEC) and Health have reviewed the Draft Engineering Evaluation/Cost Analysis (EE/CA) Approval Memorandum for the Miscellaneous Components Burial Site (SEAD-63.) We have no objection to SEDA moving forward in the development of an EE/CA for this site.

We note there is discussion in the Approval Memorandum in which elevated levels of certain constituents in groundwater are attributed to effects of sample turbidity. Perhaps low-flow sampling should be performed during the planned removal action so that groundwater analyses from samples with low turbidity could be available for the post-removal action discussion of the environmental conditions of this site.

If you have any comments or questions on this matter, please contact me by telephone at (518)457-3976 or by e-mail at jaquinn@gw.dec.state.ny.us.

Sincerely,

James A. Quinn
Bureau of Eastern Remedial Action
Division of Environmental Remediation

c: C. Struble
D. Geraghty
M. Peachey

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2.0 SITE CHARACTERIZATION

2.1 BASE DESCRIPTION AND HISTORY

This section provides a brief overview of SEDA and the conditions at the Miscellaneous Component Burial Site. The site was evaluated in 1994 as part of an Army effort to determine the conditions at several SWMUs that were considered to potentially pose a threat to human health and the environment. A more detailed discussion can be found in the draft Expanded Site Inspection Report for Seven Low Priority AOCs, SEADs 60, 62, 63, 64 (A, B, C, and D), 67, 70 and 71, April 1995.

The SEDA facility is situated on the western flank of a topographic high between Cayuga and Seneca lakes in the Finger Lakes region of central New York (**Figure 2-1**). Within the SEDA is the Miscellaneous Components Burial Site, located on the east side of North-South Baseline Road in the northwestern portion of the SEDA (**Figure 2-2**). The SEDA was constructed in 1941 and has been owned by the United States Government and operated by the Department of the Army since this time. The post generally consists of an elongated central area for storage of ammunitions and weaponry in quonset-style buildings, an operations and administration area in the eastern portion, and an army barracks area at the north end of the depot. The base was expanded to encompass a 1,524-meter airstrip, formerly the Sampson Air Force Base. The mission of the SEDA has been primarily the management of munitions. Currently, SEDA is used for the following purposes: 1) receiving, storing, and distributing ammunition and explosives, 2) providing receipt, storage, and distribution of items that support special weapons and 3) performing depot-level maintenance, demilitarization, and surveillance on conventional ammunition and special weapons. The depot formerly employed approximately 1,000 civilian and military personnel. Within the last year, the facility has undergone a downsizing and no longer houses a large contingent of military personnel.

The Miscellaneous Components Burial Site (SEAD-63) is approximately 480 by 300 feet and is bound by paved roads on the north, south, and west and by open grassland to the east (**Figure 2-3**). The site is mostly undeveloped except for a grass-covered bunker in the southeast corner and an elevated former machine-gun turret made of soil in the northwest corner. A noticeable feature of the site is a crushed shale road that enters the site via Patrol Road and leads to a crushed shale pad measuring about 100 by 100 feet. In general, the western half of the site is less vegetated and appears to have been physically worn by vehicular traffic.