U.S. ARMY ENGINEER DIVISION
HUNTSVILLE, ALABAMA

FINAL
VOLUME I OF II

FEASIBILITY STUDY REPORT AT THE ASH LANDFILL SITE

DECEMBER 1996

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ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ARAR	Applicable, or Relevant and Appropriate Requirement
ASP	Analytical Services Protocol
AWQS	Ambient Water Quality Criteria
B	Soil Boring
BRA	Baseline Risk Assessment
D	Class D NYSDEC Surface Water Classification
CERCLA	Comprehensive Environmental Responsibility, Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CLP	Contract Laboratory Program
cm^2	square centimeter
CWA	Clean Water Act
cy	cubic yards
DCE	Dichloroethene
DOT	Department of Transportation
DQO	Data Quality Objective
DWQS	Drinking Water Quality Standard
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
ES	Engineering-Science, Inc.
F	Includes Consumption of Fish Only
F-Listed	RCRA F-Listed Hazardous Waste
FS	Feasibility Study
GA	NYSDEC groundwater classification suitable as a source for drinking water
GRI	Gas Research Institute
HEAST	USEPA Health Effects Summary Table
HI	Hazard Index
hr	hour
I.D.	Inside Diameter
IRM	Interim Remedial Measure
L	Liter
LDR	Land Disposal Restriction
LOT	Limit of Tolerance
LTTD	Low Temperature Thermal Desorption
MAIN	Charles T. Main, Inc. (now known as Engineering-Science, Inc.)
MC	Migration Control
MCL	Maximum Contaminant Level
MDL	Minimum Detection Limit
mg	milligrams
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mL	milliliters
MSL	Mean Sea Level
NA	Not Available
NCFL	Non-Combustible Fill Landfill

ACRONYMS AND ABBREVIATIONS
(Con't)

NCP	National Contingency Plan
ND	Not Detected
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYCRR	New York Codes, Rules, Regulations
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
pH	pH Standard Units
PM-10	Particulate Matter with a diameter $\leq$ 10um
POTW	Publicly-Owned Treatment Works
ppb	parts per billion
ppm	parts per million
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments Reauthorization Act
SB	Site Background
SC	Source Control
SCG	Standards, Criteria, or Guidelines
SD	Sediment Sample Designation
SEAD	Former acronym for the Seneca Army depot used to designate SWMU numbers
SEDA	Seneca Army Depot Activity
SPDES	State Pollution Discharge Elimination System
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
SW	Surface Water
SWMU	Solid Waste Management Unit
TAGM	Technical and Administrative Guidance Memorandum
TBC	To be Considered
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TOGS	Technical and Operational Guidance Series
tph	tons per hour
TSDF	Treatment, Storage and Disposal Facility
Tyvek	Trade name for Personal protective Clothing
UCL	Upper Confidence Limit
ug/l	micrograms per liter
UV	Ultraviolet
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency

ACRONYMS AND ABBREVIATIONS
(Con't)

USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USFWS	U.S. Fish and Wildlife Service
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
W&F	Includes consumption of Water and Fish
1,2-DCE	1,2-Dichloroethene, same as DCE

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

This Feasibility Study (FS) report for the Ash Landfill site at the Seneca Army Depot Activity (SEDA) is a continuation of the Remedial Investigation/Feasibility Study (RI/FS) process required for compliance with the Comprehensive Environmental Response and Compensation Liability Act (CERCLA) of 1980 and the Superfund Amendments Reauthorization Act (SARA) of 1986. This program has been performed under the guidance of the US Environmental Protection Agency (EPA), Region II, and the New York Department of Environmental Conservation (NYSDEC). The RI was completed in 1993 and the final draft RI report was submitted to EPA and NYSDEC; SEDA is under the command control of the Tobyhanna Army Depot in Tobyhanna, PA. The RI was completed to fully characterize the nature and extent of human health and environmental risks posed by the Ash Landfill site.

SEDA is currently an active Army facility however, the depot has been placed on the closure list for BRAC 95. The Ash Landfill which is now inactive, is part of SEDA. The current site uses include occasional base maintenance activities and hunting. These activities are the only currently planned future uses of the site. The current intended future land use of the Ash Landfill has not been finalized but will be determined by the Local Redevelopment Authority (LRA) in conjunction with the Army. As required by CERCLA and Army regulations, if control of parcels at SEDA is released or transferred and the site-use changes, the Army must perform any remedial actions necessary to ensure that the site conditions are protective of human health and the environment.

A baseline risk assessment (BRA) was conducted for the RI at the Ash Landfill. The risk assessment included an analysis of four receptor categories. These are: 1) current off-site residents, 2) current and future on-site hunters, 3) future on-site construction workers, and 4) future on-site residents. A hazard index and cancer risk were calculated for each applicable receptor exposure route, and a total receptor risk was also calculated. The risk calculations presented in the RI report and summarized in Table 1-1 indicate that under the current and intended future land use scenarios (off-site resident, on-site construction worker, on-site hunter) the risks are within the acceptable levels defined by EPA. Under the future residential site use scenario the site risks exceed the EPA defined target levels. These risks are almost entirely due to the volatile organics present in groundwater.

TABLE 1-1
CALCULATION OF TOTAL NONCARCINOGENIC AND CARCINOGENIC RISKS

SENECA ARMY DEPOT
ASH LANDFILL

RECEPTOR	EXPOSURE ROUTE	HAZARD INDEX	CANCER RISK
CURRENT RESIDENTIAL			
CURRENT OFF-SITE RESIDENTS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	1.4E-01	5.6E-06
	Dermal Contact to Groundwater	3.2E-03	2.5E-07
	Inhalation of Groundwater while Showering	3.1E-07	1.1E-07
	Inhalation of Volatile Organics in Ambient Air	7.5E-03	2.8E-05
TOTAL RECEPTOR RISK (Nc & CAR)		1.6E-01	4.3E-05
CURRENT AND FUTURE			
ON-SITE HUNTERS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Onsite Soils	9.5E-04	2.2E-07
	Dermal Contact to Onsite Soils	1.4E-03	4.4E-08
	Inhalation of Volatile Organics in Ambient Air	3.6E-04	1.4E-06
TOTAL RECEPTOR RISK (Nc & CAR)		7.8E-03	1.1E-05
FUTURE ON-SITE CONSTRUCTION WORKERS	Ingestion of Onsite Soils	9.3E-03	1.9E-06
	Dermal Contact to Onsite Soils	5.4E-02	1.4E-06
	Inhalation of Volatile Organics in Ambient Air	1.4E-02	4.3E-05
TOTAL RECEPTOR RISK (Nc & CAR)		7.7E-02	4.6E-05
FUTURE RESIDENTIAL			
FUTURE ON-SITE RESIDENTS	Ingestion of Onsite Soils	3.4E-01	2.0E-05
	Dermal Contact to Onsite Soils	3.8E-01	4.6E-06
	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	3.2E+00	1.4E-03
	Dermal Contact to Groundwater	2.0E-01	7.1E-05
	Inhalation of Groundwater while Showering	1.0E-01	2.9E-05
	Inhalation of Volatile Organics in Ambient Air	3.2E-02	1.2E-04
TOTAL RECEPTOR RISK (Nc & CAR)		4.3E+00	1.7E-03
TOTAL SOIL RISK		8.4E-01	2.2E-04
TOTAL GROUNDWATER RISK		3.6E+00	1.5E-03
TOTAL SEDIMENT RISK		6.0E-03	0.0E+00
TOTAL SURFACE WATER RISK		6.2E-03	1.8E-05
CURRENT SOIL RISK		8.8E-02	7.6E-05
FUTURE SOIL RISK		7.5E-01	1.4E-04

Because the risks associated with a future residential scenario exceed the EPA-defined target levels, remedial activities that address these risks will be evaluated. The results of the risk assessment are discussed in detail in Section 2.0 of this report. This FS will focus on the current and intended future land uses as the basis for remedial action decisions.

This report is organized in accordance with "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," EPA/540/G-89/004, October 1988. Section 1.0 is divided into five subsections which provide an overview of site conditions, including a brief review of the RI report. Section 1.2 describes the site background. Sections 1.2.1 and 1.2.2 describe the site history, including a site description and the local geologic and hydrogeologic setting. Section 1.3 summarizes the nature and extent of contamination. Section 1.4 discusses the contaminant fate and transport, and Section 1.5 presents the conclusions of the Baseline Risk Assessment (BRA).

Section 2.0 identifies and describes the initial screening of the remedial technologies. Remedial action objectives are developed for each media of concern (soil/sediment and groundwater), and general response actions are considered which meet the remedial objectives for each media. The remedial technologies within each response category are screened for technical feasibility for implementation at the Ash Landfill site. The discussion of remedial technologies are divided into source and migration control technologies. It is possible that both source and migration control technologies will be necessary at the Ash Landfill site, though the implementation of each program may be independent.

Technologies remaining from the initial screening are combined into remedial alternatives and are presented in Section 3.0. Alternatives for each media are evaluated to determine its relative merit for use in the remedial action. These alternatives are then screened and are evaluated, in detail, in Section 5.0. Also included in Section 5.0 are detailed descriptions of the technologies and their implementation, along with cost estimates. Section 4.0 describes the treatability testing that may be necessary for alternatives that include innovative technologies prior to implementation of the remedial actions.

1.1.1 Operable Units

In order to facilitate the remedial actions, the Ash Landfill site has been combined into one operable unit from several operable units. An operable unit, as defined by EPA (40 CFR 300.5) is:

> "a discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration, or eliminates or mitigates a release, threat of a release, or pathway of exposure. The cleanup of a site may be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different portions of the site."

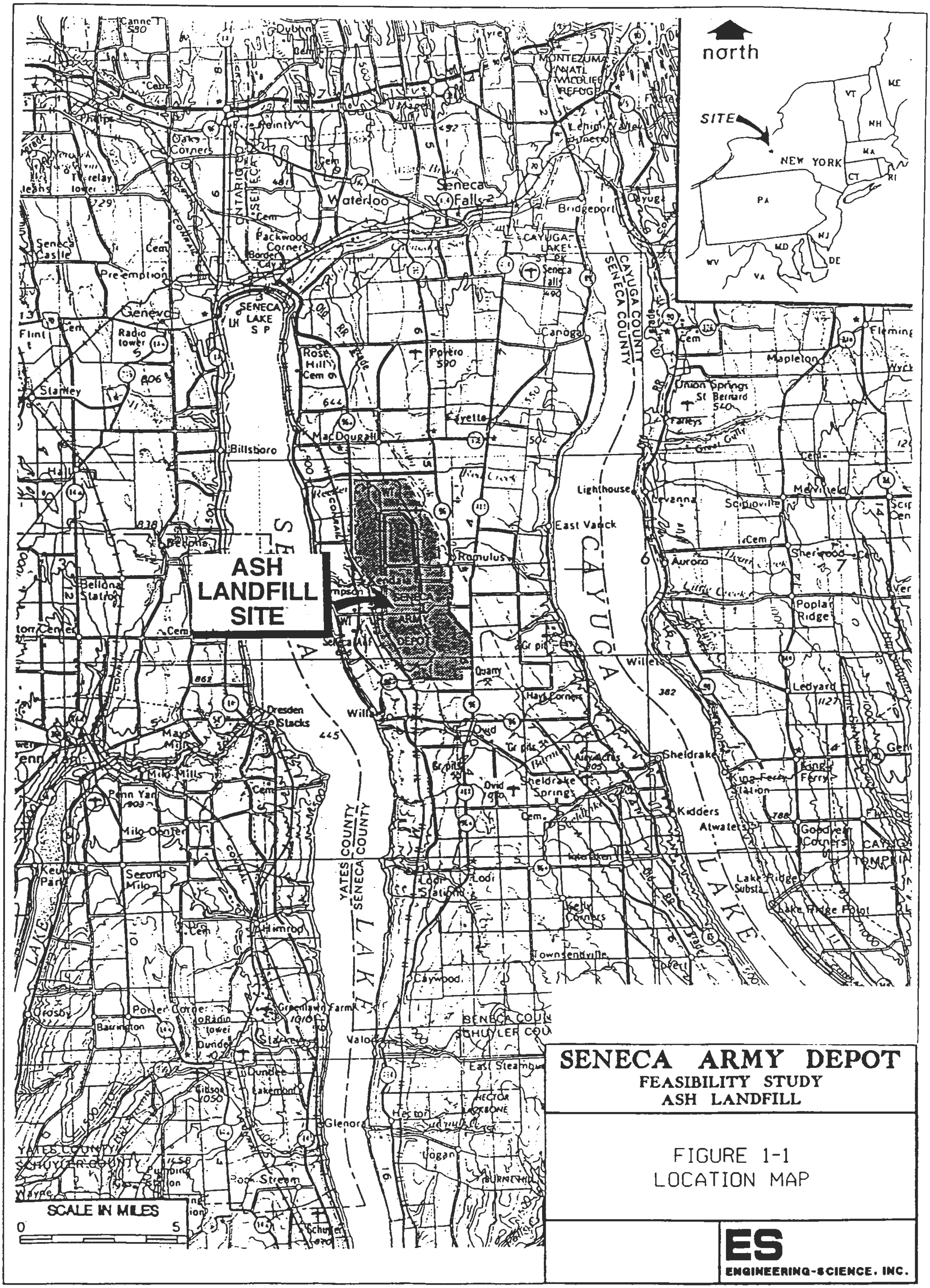
The following areas, originally have been designated as Solid Waste Management Units (SWMUs), have been combined as the Ash Landfill operable unit. The Ash Landfill was also originally designated as a SWMU (SEAD-6).

- Incinerator Cooling Pond
- Non-Combustible Fill Landfill
- Refuse Burning Pits (2 Units)
- Building 2207 - Abandoned Solid Waste Incinerator
- Buried Debris Piles
- Cooking Grease Pit/Disposal Area
- Underground Diesel Fuel Tank
- Solvent Dump Sites (3)
- Burning Pits

1.2 SITE BACKGROUND

1.2.1 Site Description

SEDA is an active military facility constructed in 1941. The site is located approximately 40 miles south of Lake Ontario, near Romulus, New York as shown in Figure 1-1. The facility is located in an uplands area, at an elevation of approximately 600 feet Mean Sea Level (MSL), that forms a divide separating two of the New York Finger Lakes, Cayuga Lake on the east and Seneca Lake on the west. Sparsely populated farmland covers most of the surrounding area. New York State Highways 96 and 96A adjoin SEDA on the east and west boundaries, respectively. Since its inception in 1941, SEDA's primary mission has been the receipt, storage, maintenance, and supply



SENECA ARMY DEPOT

FEASIBILITY STUDY

ASH LANDFILL

FIGURE 1-1

LOCATION MAP

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of military items. The Ash Landfill site encompasses approximately 130 acres of the 10,587 acre SEDA. Figure 1-2 presents a plan view of SEDA and identifies the location of the Ash Landfill site. The Ash Landfill site consists of an abandoned incinerator building and tower (Building 2207), a former cooling pond, an ash landfill, and a nearby Non-Combustible Fill Landfill (NCFL) as shown in Figure 1-3. The site is bounded on the north by Cemetery Road, on the east by a SEDA railroad line, on the south by undeveloped SEDA land, and on the west by the depot's boundary. Beyond the depot's western boundary are farmland and residences on Smith Farm Road and along Route 96A. Sampson State Park on the shore of Seneca Lake is located immediately to the west of Route 96A.

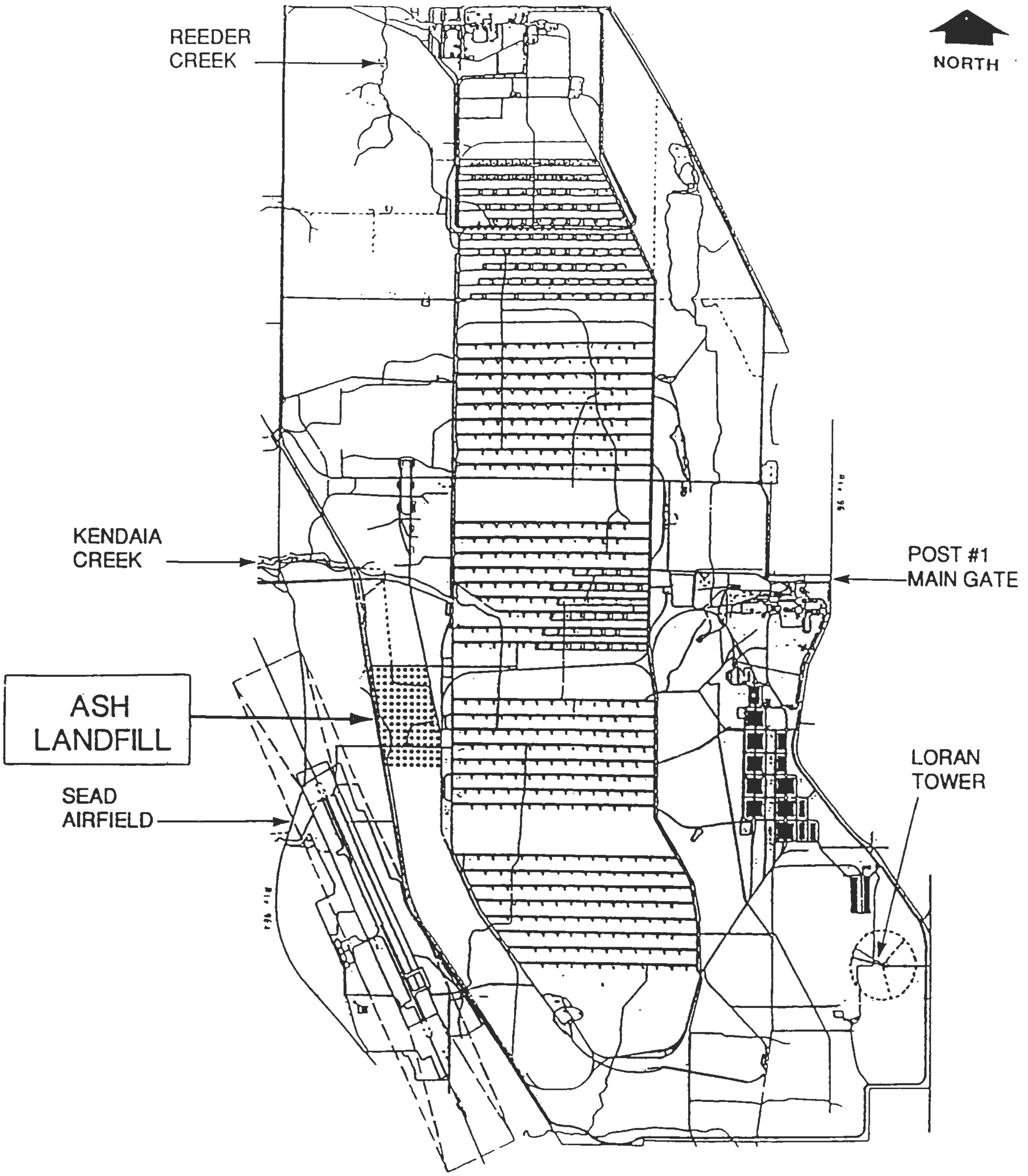
The Ash Landfill was previously used by the Army for disposal of ash generated from the incineration of solid waste (trash) produced at the depot. The NCFL is located east of the incinerator building on the south side of West Smith Farm Road. This landfill was the repository of materials that could not be burned in the incinerator.

1.2.1.1 Geologic Setting

The site 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 shales, sandstones, conglomerates, limestones and dolostones.

The Hamilton Group, which underlies the site, is 600 to 1500 feet thick, and is divided into four formations. They are, from oldest to youngest, the Marcellus, Skaneateles, Ludlowville, and Moscow formations. The western portion of SEDA is generally located in the Ludlowville Formation while the eastern portion is located in the younger Moscow Formation. The Ludlowville and Moscow formations are characterized by gray, calcareous shales and mudstones and thin limestones with numerous zones of abundant invertebrate fossils that form geographically widespread encrinites, coral-rich layers, and complex shell beds. In contrast, the lower two formations (Skaneateles and Marcellus) consist largely of black and dark gray sparsely fossiliferous shales (Brett et al., 1991). Locally, the shale is soft, gray, and fissile.

Pleistocene age (Late Wisconsin age, 20,000 years bp) glacial till deposits overlie the shales. The till matrix, the result of glaciation, varies locally but generally consists of horizons of unsorted silt, clay, sand, and gravel. The soils at the site contain varying amounts of inorganic clays, inorganic silts, and silty sands. In the central and eastern portions of SEDA the till is thin and bedrock is



SENECA ARMY DEPOT
FEASIBILITY STUDY
ASH LANDFILL

FIGURE 1-2
LOCATION OF ASH LANDFILL
AT THE SENECA ARMY DEPOT
ACTIVITY

Source: Seneca Army Depot

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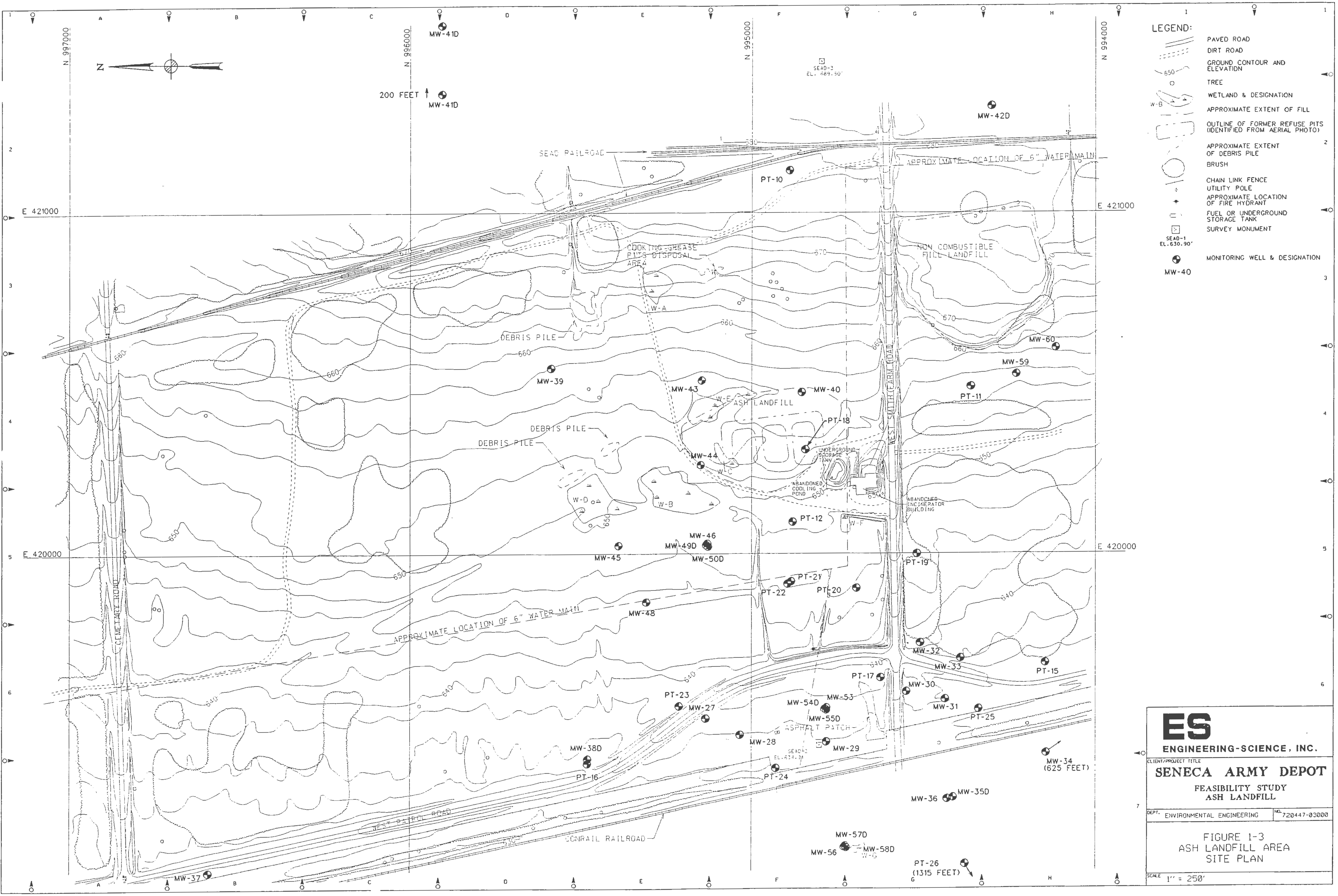

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FIGURE 1-3
ASH LANDFILL AREA
SITE PLAN

SCALE 1'' = 250'

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exposed or within 3 feet of the surface in some locations. Thickness of the glacial till deposits at SEDA generally ranges from 1 to 15 feet.

Darien silt-loam soils, 0 to 18 inches thick, have developed over Wisconsin age glacial tills. These soils are developed on glacial till where they overlie the shale. In general, the topographic relief associated with these soils is 3 to 8 percent.

Regionally, four distinct hydrologic units have been identified within Seneca County (Mozola A.J., 1951). These include two distinct shale formations, a series of limestone units, and unconsolidated beds of Pleistocene glacial drift. Overall, the groundwater in the county is very hard, and therefore, the quality is minimally acceptable for use as potable water. The water table aquifer of the unconsolidated surficial glacial deposits of the region 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, (Mozola, 1951, and Crain, 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 flow is expected to be westward toward Seneca Lake.

The geologic information reviewed indicates that the upper portions of the shale formation would be expected to yield small, yet adequate, supplies of water for domestic use. For mid-Devonian shales such as those of the Hamilton group, the average yields, (which are less than 15 gpm), are consistent with what would be expected for shales (LaSala, 1968). The deeper portions of the bedrock, (at depths greater than 235 feet) have provided yields up to 150 gpm. At these depths, the high well-yields may be attributed to the effect of solution on the Onondaga limestone, which is at the base of the Hamilton Group. Based on well-yield data, the degree of solution is affected by the type and thickness of overlying material (Mozola, 1951). Solution effects on limestones (and on shales which contain gypsum) in the Erie-Niagara have been reported by LaSala (1968). This source of water is considered to comprise a separate source of groundwater for the area. 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.

1.2.2 Site History

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. Prior to construction of the depot, the site

was used for farming. From 1941 to 1974, uncontaminated trash was burned in a series of burn pits near the abandoned incinerator building (Building 2207). According to a U.S. Army Environmental Hygiene Agency (USAEHA) Interim Final Report, Groundwater Contamination Survey No. 38-26-0868-88 (July 1987), during approximately this same period of time (1941 until the late 1950's or early 1960's) the ash from the refuse burning pits was buried in the landfill.

The incinerator building was built in 1974. Between 1974 and 1979, materials intended for disposal were transported to the incinerator. The incinerator was a multiple chamber, batch-fed 2,000 pound per hour capacity unit which burned rubbish and garbage. The incinerator unit contained an automatic ram-type feeder, a refractory lined furnace with secondary combustion and settling chamber, a reciprocating stoker, a residue conveyor for ash removal, combustion air fans, a wet gas scrubber, an induced draft fan, and a refractory-lined stack (USAEHA, 1975). Nearly all of the approximately 18 tons of refuse generated per week on the depot were incinerated. The source for the refuse was domestic waste from depot activities and family housing. Large items which could not be burned were disposed of at the NCFL.

Ashes and other residues from the incinerator were temporarily disposed of in an unlined cooling pond immediately north of the incinerator building. The cooling pond consisted of an unlined depression approximately 50 feet in diameter and approximately 6 to 8 feet deep. When the pond filled (approximately every 18 months), the fly ash and residues were removed, transported, and buried in the adjacent landfill east of the cooling pond. The refuse was dumped in piles and occasionally spread and compacted. No daily or final cover was applied. The active area of the Ash Landfill extended at least 500 feet north at the incinerator building, near a bend in a dirt road, based on an undated aerial photograph of the incinerator during operation. Parallel grooves at the northernmost extent of the filled area are visible in the aerial view of the incinerator and adjacent fill area during active operation and indicate that the fill was spread using a bulldozer or similar equipment. The incinerator was destroyed by a fire on May 8, 1979, and the landfill was subsequently closed. The landfill was apparently covered with native soils of various thicknesses but has not been closed with an engineered cover or cap.

A grease pit disposal area near the eastern boundary of the site was used for disposal of cooking grease. Evidence of burning of debris during the operation of the incinerator is included areas of blackened soil, charred debris and areas of stressed or dead vegetation.

The approximately 2-acre NCFL southeast of the incinerator building (immediately south of the SEDA railroad line) was used as a disposal site for non-combustible materials including construction debris from 1969 until 1977.

1.2.2.1 Previous Investigations

Soil sampling, well installation, groundwater sampling, surface water, and sediment sampling have all been performed under various investigative programs conducted at the Ash Landfill. Information is available on the overburden conditions and the direction of groundwater flow at the site with a level of detail sufficient to initially characterize the physical setting.

The following reports have provided data on the Ash Landfill:

1. Army Pollution Abatement Program Study No. D-1031-W Landfill Leachate Study No. 81-26-8020-81, 1979, conducted by USAEHA.
2. Installation Assessment of Seneca Army Depot Report No. 157, 1980, conducted by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA).
3. Interim Final Report Groundwater Contamination Survey No. 35-26-0568-88, Evaluation of Solid Waste Units, 1987, conducted by USAEHA.
4. Geohydrologic Study No. 38-26-0313-88, 1987, conducted by USAEHA.
5. Remedial Investigation Feasibility Study, 1989, conducted by USATHAMA/ICF, Inc. Site Investigation, 1989, conducted by Hunter/ESE.
6. Quarterly Groundwater Monitoring (1987-1993).

All previous investigations of the Ash Landfill site are summarized in chronological order in the RI.

1.3 NATURE AND EXTENT OF CONSTITUENTS OF CONCERN

The nature and extent of the chemicals of concern at the Ash Landfill were evaluated through a comprehensive field investigation program. Primary media investigated at the Ash Landfill included soil (from soil borings and test pits), surface water and sediment (from Kendaia Creek and on-site wetlands and drainage swales), and groundwater (from monitoring wells). The primary chemicals of concern at the Ash Landfill are volatile organic compounds (primarily chlorinated and aromatic compounds), semivolatile organics (mainly Polynuclear Aromatic Hydrocarbon [PAHs]), and to a lesser degree metals. These contaminants are believed to have been released to the environment during former landfilling activities conducted at the Ash Landfill site.

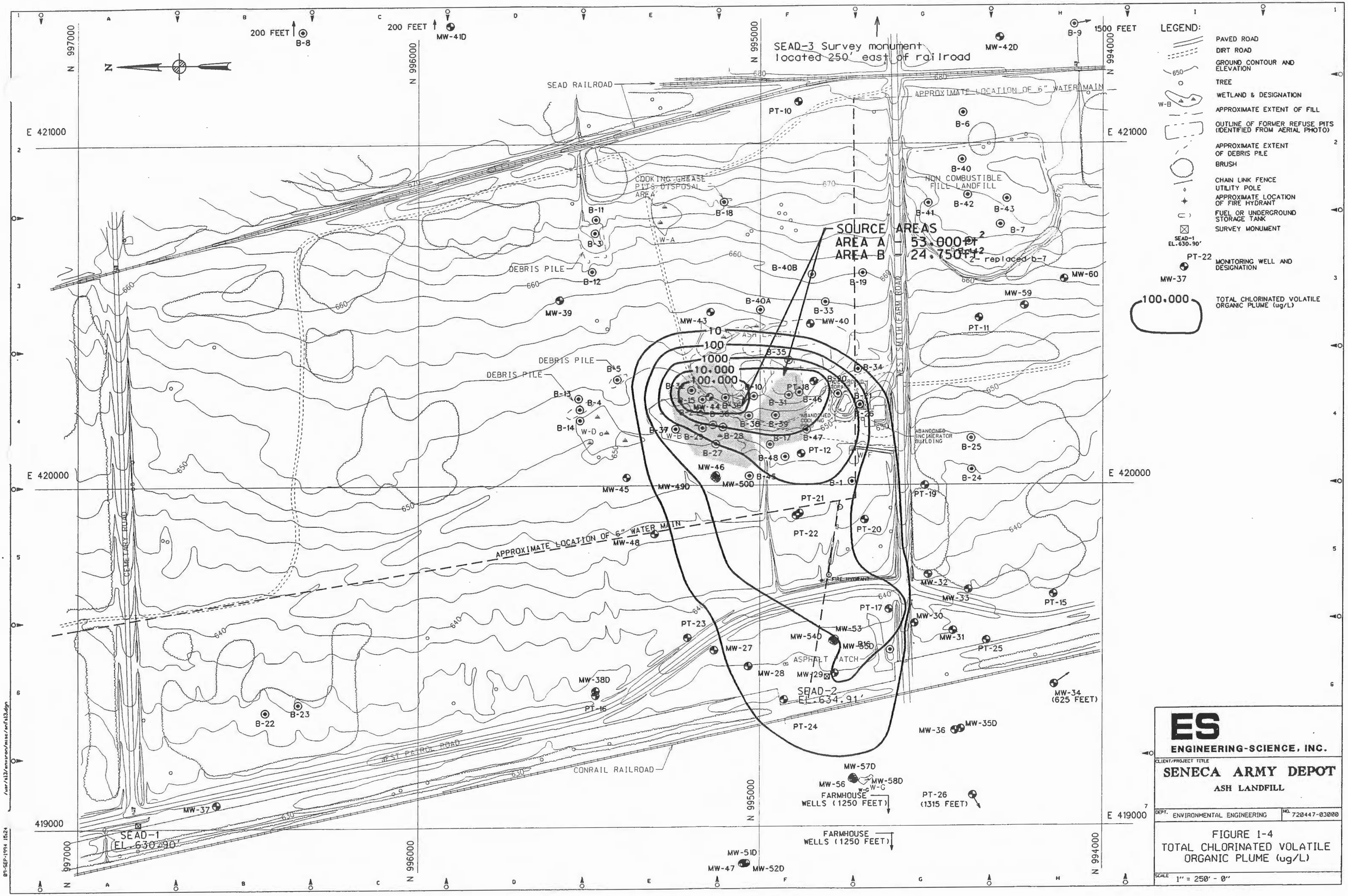
The primary chlorinated volatile organic compounds in soils at the Ash Landfill site were 1,2-dichloroethene (1,2-DCE), trichloroethene (TCE), and vinyl chloride (VC). The highest concentrations of these compounds were measured in a two acre area northwest of the Ash Landfill near the "Bend in the Road". The two source areas for the volatile organic compounds (i.e., Areas A and B near the "Bend in the Road") were identified using soil gas surveys and soil borings. Concentrations of volatile chlorinated organics above the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) clean-up guidelines were measured in this area at all depths from land surface to the top of the weathered shale. TAGMS are used by NYSDEC for establishing cleanup guidelines. The TAGMS are not promulgated standards and therefore are not ARARs but rather are To Be Considered (TBC) guidelines. As such, remedy selection will be based upon other enforceable standards that are ARARs. However, if appropriate, TAGMs may be used to help determine treatment volumes such as cubic yards of soil. As with the chlorinated compounds, the highest concentrations of volatile aromatic organic compounds occurred northwest of the Ash Landfill in the same area. The primary aromatic constituents of concern were xylene and toluene which were also measured at concentrations above the TAGM cleanup guidelines. The horizontal extent of the aromatics were smaller than that for the chlorinated volatile organics, approximately one-half acre, and the vertical impacts extended from the land surface to 4 feet below the surface (above the water table).

It is noteworthy that the source area for the chlorinated volatile organic compounds was remediated during a non-time critical removal action. This removal action was performed between August 1994 and June 1995. Details of the removal action are presented in Section 1.6

The other compounds of significance measured in the soils were semi-volatile organics and metals. PAHs were measured at concentrations above the TAGM clean-up guidelines in the Ash Landfill, in the NCFL and in the various debris piles present around the former Ash Landfill. In general, the highest PAH concentrations were detected in the NCFL and small debris pile surface soils (0 to 2 feet) that contained the residues of incomplete combustion. The metals that were detected at elevated concentrations (significantly above the TAGM) in soils were copper, lead, mercury and zinc. These elevated concentrations were found in the Ash Landfill, in the NCFL and in the debris piles. The highest concentrations of metals were detected at the surface of the debris piles. These piles are small, localized, surface features that are visibly discernable and do not extend into the subsurface.

The primary impact to the groundwater is a plume of a chlorinated volatile organic compounds containing dissolved concentrations of TCE, 1,2-DCE and VC that originates in the area of the formerly contaminated soils at the "Bend in the Road" near the western edge of the Ash Landfill. This plume extends westward to the depot boundary (Figure 1-4). The maximum detected volatile concentration was 204,000 µg/l, which is the sum of TCE, 1,2-DCE, and VC in monitoring well MW-44 located within the area considered to be the source area. The plume is believed to extend approximately 100 feet beyond the depot boundary and may contain a total chlorinated concentration of 10 µg/l at this location. The nearest exposure points for groundwater are the three farmhouse wells, located approximately 1250 feet from the leading edge of the plume. At least one of the farmhouse wells draws water from the till/weathered shale aquifer and the remaining two wells derive water from the bedrock aquifer. Vertically, the plume is believed to be restricted to the upper till/weathered shale aquifer and is not present in the deeper competent shale aquifer. No significant concentrations of semivolatile organics were detected in groundwater; two semivolatile organics were detected slightly above their applicable standards in only one well (MW-44). No significant concentrations of metals were detected in groundwater.

No volatile or semi-volatile organic compounds were detected in any of the on-site surface waters or Kendaia Creek. Metals concentrations were also low in surface water with only iron exceeding NYSDEC water quality standards (6 NYCRR Subparts 701-705) in three of the six on-site wetlands. The sediments of the wetland adjacent to the "Bend in the Road" (Wetland W-B) contained elevated concentrations of 1,2-DCE. No other on-site sediments contained concentrations of volatile or semi-volatile organics. Metals concentrations in several sediments samples exceeded NYSDEC guidelines with the highest concentrations occurring in wetland W-B.



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NO. 720447-03000

FIGURE 1-4
TOTAL CHLORINATED VOLATILE ORGANIC PLUME (ug/L)

SCALE 1" = 250' - 0"

1.4 FATE AND TRANSPORT

Analysis of the fate and transport mechanisms for the chemicals of concern at the Ash Landfill considered site specific factors as well as the chemical/physical properties of the target analytes. Soil, sediment, and surface water samples collected off-site, and downstream of the site were used to quantify the extent of impacts to various media. An important transport mechanism for volatile chlorinated hydrocarbons is the release to groundwater and subsequent downgradient transport.

Fugacity modeling was performed to determine the likely partitioning of the chlorinated organics between the soil, soil-water and soil-airspace phases. This modeling was qualitative and not site specific. This analysis indicated that volatile organic chemicals of concern will partition equally in the soil-water and soil-airspace with the exception of vinyl chloride which will partition mostly into the airspace. Furthermore, the data suggests that the TCE is being biodegraded in the soil to 1,2-DCE. The 1,2-DCE is being further biodegraded to vinyl chloride. Since vinyl chloride is a gas at ambient conditions, it is likely that the vinyl chloride is ultimately released from the soil as a vapor. Cursory groundwater transport modeling was performed using the model ODAST to compare the downgradient rate of transport of TCE and DCE. The modeling indicated that the VOC plume may have reached a steady state condition and that natural attenuation was a possible consideration for remedial action at the site. VC was not modeled because the groundwater quality data did not detect the presence of VC in the downgradient monitoring wells. This suggests that VC is being removed from the groundwater system prior to being transported. This removal mechanism is likely to be volatilization which is consistent with the fugacity modeling described previously. More recently, a simulation of the groundwater flow and transport system at the Ash Landfill using the MODFLOW and MT3D numerical models indicated that the plume would, over many years, move slowly off-site, but diminish in concentration and size over time because the source of the VOCs at the "Bend in the Road" has been removed. The results of these numerical models are presented in the Draft Groundwater Modeling Report (Parsons ES, 1995) which is included in Appendix F.

1.5 RISK ASSESSMENT

1.5.1 Baseline Human Health Risk Assessment

The current and future intended land use is as the land is currently being used, which is as a meadow and occasionally for hunting deer. There are no current plans to use this site for

residential purposes. The on-site residential exposure scenario will not be used as a basis for establishing remedial action goals even though this exposure scenario was considered in the BRA. The reason for this is that there are no current plans to use the site for residential purposes and, therefore, it is an unreasonable basis for establishing remedial action goals. This is particularly true since the site is fenced, patrolled and has restricted access because it is an active military installation. The future intended use of the site has yet to be definitively determined by the BRAC process.

The future intended use of the site has yet to be definitely determined by the BRAC process. As part of the BRAC process, the future land use of this site will be determined by the Local Redevelopment Authority (LRA) in conjunction with the Army. As of July 1996, the LRA has recommended to the Army specific reuse alternatives for several areas at SEDA. Residential use has been recommended for Elliot Acres Housing and the Lake Front Housing. Storage buildings have been recommended for industrial use, and the north Administration Area has been recommended for institutional use. The LRA has designated the future use of the remaining sites at SEDA including the Ash Landfill site to be a wildlife management area.

Human health risk assessments were calculated for four exposure scenarios:

1) Current off-site residents;
2) Current and future on-site hunters,
3) Future on-site construction workers; and
4) Future on-site residents.

The results of the risk assessment indicate that the potential future residents of the site are the only receptors exhibiting cancer risks above the EPA target risk range and exhibit a potential for adverse noncarcinogenic health threats. For this exposure scenario, the excess cancer risk of 1.7×10^{-3} and the hazard index of 4.2 are due primarily to potential exposure of receptors to groundwater as their sole drinking water source. Groundwater sampling performed as part of this investigation, in addition to several years of groundwater monitoring have confirmed that the current off-site residents do not exhibit an increased risk of cancer in excess of the target risk range or adverse noncarcinogenic health threats. The carcinogenic risks for the off-site receptor were found to be 4.3×10^{-5} and are within the EPA's target risk range. Additionally, the Hazard Index (HI) of 0.16 is less than the EPA defined non-carcinogenic HI target risk value of one. The cancer risks for the on-site hunter and the on-site construction worker scenarios are 1.1×10^{-5} and 4.6 x

risks for the on-site hunter and the on-site construction worker scenarios are 1.1 x 10^{-5} and 4.6 x 10^{-5}, respectively, and the hazard indices are also 0.0078 and 0.077 respectively.

Although risks are exhibited by potential future residents using groundwater for drinking, the U.S. Army currently does not intend to use this land for residential purposes. Accordingly, it is unreasonable to establish remedial action objectives and remediate this parcel to conditions that would permit such land use. For the purposes of this feasibility study, any decisions pertaining to implementing a remedial action will be based upon the current and intended future land use. This includes the risk from Scenarios 1 through 3. Should the intended future land use become residential, then in accordance with U.S. Army regulations and CERCLA the U.S. Army will notify all appropriate regulatory bodies and perform any remedial action necessary to meet the risk requirements for this land use scenario.

1.5.2 Ecological Risk Assessment

The ecological risk assessment included both a qualitative and quantitative assessment of the ecological status of the Ash Landfill. During Phase I and Phase II, field evaluations included fish trapping and counting, benthic macroinvertibrate sampling and counting and small mammal species sampling and counting. In addition, a vegetation survey was performed, identifying major vegetation and understory types. The conclusions determined from these field efforts indicated a diverse and healthy aquatic and terrestrial environment. No overt acute toxic impacts were evidenced during the field evaluation.

Quantitative soil, sediment and surface water analytical data were compared to EPA and NYSDEC guidelines and standards for the protection of aquatic and macroinvertebrate life in sediments and surface water. Additionally, as a supplement to specific guidelines, criteria were developed to be protective of terrestrial wildlife and vegetation in soils. The quantitative evaluation which involved comparison of the 95th Upper Confidence Limit (UCL) of the mean of site data with the media specific criteria, suggested a slight potential for chronic risk from heavy metals. The acute effects from these metals have not been observed during fieldwork, i.e. the ecological community appears diverse and normal, however, long term chronic impacts are more subtle. For example, calculated chronic toxicity concentrations for aquatic (mallard) wildlife were exceeded by lead in soil at the 95th UCL. For the protection of aquatic life in contact with sediments, the 95th UCL for nine metals, arsenic, cadmium, copper, iron, lead, manganese, mercury, nickel and zinc did exceed the NYSDEC guidelines. However, the Limits of Tolerance (LOT) criteria for the protection of

benthic macroinvertebrates were not exceeded for any metals in sediments. Federal surface water chronic toxicity criteria for the protection of aquatic life were exceeded for five metals, aluminum, antimony, iron, lead, and mercury, and NYSDEC criteria were exceeded by iron. However, no metal exceeded the Federal acute toxicity criteria for the protection of aquatic life. For protection of terrestrial vegetation, only soil concentrations of cadmium and zinc at the 95th UCL exceeded regulatory guidelines or concentrations estimated to cause phytotoxicity. In summary, on-site soils, surface waters and sediment suggest the site conditions may pose a slightly elevated ecological risk due to the presence of heavy metals. However, these criteria are not considered ARARs since none of these criteria are promulgated standards. Only the NYSDEC water quality criteria, which is a promulgated standard for Kendia Creek is considered to be an ARAR. No exceedences of this ARAR was observed. Although, some metal exceedences were observable for guidelines and reported literature values, the actual risk caused by these exceedences is uncertain and not readily observable. Furthermore, the use of the on-site wetlands and surface waters by aquatic species is unlikely since these wetlands are small and are dry during a large portion of the year.

1.6 NON-TIME CRITICAL REMOVAL ACTION

A non-time critical removal action was conducted by the Army under the requirements of the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA), as amended. The removal action consisted of the treatment of VOC-impacted soils at the Ash Landfill using Low Temperature Thermal Desorption (LTTD). The scope of the removal action is described in an "Action" Memorandum, Ash Landfill Removal Action" (ES, 1993). The Action Memorandum also includes an Engineering Evaluation/Cost Analysis (EE/CA) that provides a full description of the technology screening and selection process used to choose LLTD as the remedial action technology. Appendix A contains calculations of the air emissions for the source removal excavation as well as emissions from the LTTD system.

Between August 1994 and June 1995, a non-time critical removal action was performed by IT Corporation on soils that were known to be the source of a plume of VOCs in groundwater at the Ash Landfill. The non-time critical removal action included treatment of soils excavated from two distinct source areas at the "Bend in the Road" using LTTD (Areas A and B) (Appendix E). Prior to initiating the removal action, a series of soil borings were completed around the two impacted areas (Appendix E). In addition, a baseline monitoring program was established to measure typical

background levels of particulates, VOCs, and polynuclear aromatic hydrocarbons (PAHs). An on-site meteorological station was also installed and monitored.

After completing these initial activities, the major portion of the non-time critical removal action was performed. The major activities included site mobilization, start-up/prove-out testing, excavating, treatment operations, backfilling, demobilization, and site restoration.

Once the site mobilization was completed, a prove-out test was performed to ensure that FERtech Environmental, the LTTD subcontractor, could start-up, check-out, operate, and shutdown all of the LTTD equipment. The prove-out test was performed by running 1,500 tons of excavated material through the LTTD unit with a set of minimum performance requirements. The prove-out included segregation of processed materials, debris handling, treatment of soils using LTTD technology, air pollution control, and verification of treated soils and air emissions. The LTTD unit met all applicable performance standards including the treatment of 500 tons of material continuously, maintaining an oven temperature of over 800 degrees Fahrenheit (F), and air emissions below applicable federal and state thresholds.

After the prove-out test, soil in the two source areas to be remediated was excavated, fed through a shaker/screen to remove large debris, and then loaded into a hopper to feed into the LTTD system. In the LTTD system, the soil was moved via a conveyor belt through a propane-fired rotary dryer for treatment. The LTTD system averaged approximately 15 tons/hour throughput and operated at a temperature range of 800-900^{o}F. After the soil was treated, it was transferred to a clean soil staging area where it was tested and eventually backfilled into the original excavation.

Treatment of wastewater and monitoring of air dispersion impacts were also required for the project. Wastewater in the excavation areas (which consisted of infiltrating groundwater, precipitation and runoff, and water generated from other project operations) was collected and pumped from the excavation to an on-site water treatment system where it was treated and discharged to a nearby field. The discharged water was periodically tested to ensure that it was being treated effectively and met discharge criteria. Air dispersion of VOCs and particulate matter generated by the project operations were monitored with three monitoring stations established around the perimeter of the project area.

As part of the non-time critical removal action approximately 35,000 tons of soil were excavated from the two source areas and treated using LTTD at the Ash Landfill. Sampling and analysis of

excavated and treated soil material indicated that these soils were successfully treated and met the VOC clean-up criteria for the project. Site-specific clean-up levels and the results of the analytical testing of pre- and post-treatment soils from the excavated areas are provided in Appendix E.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 INTRODUCTION

The purpose of this section of the feasibility study is to present and screen an appropriate range of remedial action technologies that will eventually be combined as remedial alternatives and undergo further screening in Section 3.0. Technologies were developed following the standard EPA method of identifying and screening technologies/processes. This method consists of six steps:

- Develop remedial action objectives that are risk-based, with consideration given to Applicable or Relevant and Appropriate Requirements (ARARs). The remedial action objectives are based on media of interest, chemical constituents of concern and the results of the BRA presented in Section 6.0 of the Ash Landfill RI.
- Develop general response actions for each medium of interest that will satisfy each remedial action objective for the site.
- Estimate quantities of media to which general response actions may be applied to meet remedial action objectives.
- Identify remediation technologies/processes associated with each general response action. Screen and eliminate technologies/processes based on technical implementability.
- Evaluate technologies/processes and retain processes that are representative of each technology that is retained from the technology screening.
- The retained technologies/processes are then assembled into a range of alternatives as appropriate and screened further. The remaining alternatives are then analyzed in detail.

This six-step approach to technology screening and alternatives development is described in the following subsections.

2.2 REMEDIAL ACTION OBJECTIVES

2.2.1 General Remedial Action Objectives

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process is a risk based process when considering remedial action objectives. It requires that the overall objective of any remedial response is to reduce the environmental and human health risks of the chemicals present in the various environmental media, to within established EPA target ranges. Additionally, the National Contingency Plan (NCP) requires that CERCLA remedial action objectives must comply with all ARARs. Finally, CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, requires that a CERCLA remedial action must be cost effective and must use permanent solutions to the maximum extent possible. Remedial action objectives have been developed that consist of media-specific objectives for the protection of human health and the environment. These objectives are risk-based, and comply with ARARs to the maximum extent possible.

The remedial action objectives for the Ash Landfill are based on exposure levels and associated risks posed by on-site contamination and contamination that has or may migrate off-site. These objectives consider the site characteristics that define the fate and transport of contaminants, pathways of exposure, receptors, and short and long-term health effects. The remedial action objectives for the Ash Landfill operable unit are as follows:

- Prevent public or other persons from direct contact with adversely impacted soils, sediments, solid waste and surface water that may present a health risk.
- Eliminate or minimize the migration of hazardous constituents from soil to groundwater.
- Prevent ingestion of groundwater containing constituents in excess of federal and state drinking water standards or criteria, or which pose a threat to public health.
- Prevent off-site migration of constituents above levels protective of public health and the environment.
- Restore groundwater, soil, surface water, and sediments to levels that are protective of public health and the environment.

The following sections describe how these general remedial action objectives were determined and the development of remedial actions to attain these objectives. As previously mentioned, remedial action objectives for this site will be based upon the current and intended land use scenarios. Residential land use is not a future intended land use and will not be considered further.

2.2.2 Media of Interest

The selection of the media of interest is based upon the two general remedial action objectives: those media that contribute the greatest risk and cause an exceedance of an EPA target risk level, and those media that do not comply with ARARs. The remedial investigation has examined all media at the Ash Landfill. Discrete samples of the on-site and off-site surface water, on-site and off-site sediment, on-site soil and on-site and off-site groundwater have been sampled and analyzed using EPA and NYSDEC established analytical techniques. This process has yielded high quality data meeting all established Data Quality Objective (DQO) and has been used for determining both the need to remediate, if necessary, and the extent of any required remediation program. Table 2-1 summarizes the 95th UCL of the mean for each of the constituents evaluated in the various media. In addition, field screening was performed in support of the field health and safety activities. The field screening data include ambient air monitoring for VOCs, particulate matter and radioactivity, both at the drilling location and 100 feet downwind.

The first step in developing remedial action objectives is to review the results of the Baseline Risk Assessment (BRA) presented in the RI report (ES, July 1994). In general, EPA considers that a site exhibits unacceptable risk levels if the Hazard Index (HI) for the site is greater than 1, or if the cancer risk is greater than the target range of 1×10^{-4} to 1×10^{-6}. As shown in Table 1-1, both the total hazard index and total cancer risk for the current and future land use scenarios are within the EPA target risk range, with the exception of the future on-site residential scenario.

The 95th UCL of the mean for specific analytes exceed the NYSDEC TAGM values for soil cleanup for on-site soils. The values for soil cleanup presented in NYSDEC TAGM HWR-92-4046, are not ARARs but rather To Be Considered (TBCs) because these values are not promulgated standards. These values are not used to determine the necessity of remediation but may be used as guidelines in setting remedial goals.

TABLE 2-1

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SURFACE SOIL ANALYSIS RESULTS (0-2 Foot Depths)
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL FEASIBILITY STUDY

COMPOUND	UNITS	NYSDEC TAGM*	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration
Volatile Organics						
Vinyl Chloride	ug/kg	200	750	16.02	33.24	16.02
1,2-Dichloroethene (total)	ug/kg	300	38000	584.27	1,545.47	584.27
Trichloroethene	ug/kg	700	150000	1,592.88	5,564.81	1,592.88
Semi-volatiles						
2-Methylnaphthalene	ug/kg	36,400	1250	360.05	318.57	360.05
Acenaphthylene	ug/kg	41,000	510	251.08	209.08	251.08
Dibenzofuran	ug/kg	6,200	1400	407.83	352.36	407.83
Phenanthrene	ug/kg	50,000	15000	1,047.87	998.34	1,047.87
Benzo(a)anthracene	ug/kg	220 or MDL**	9600	915.76	741.85	915.76
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	230000	987.69	4,749.60	987.69
Benzo(b)fluoranthene	ug/kg	1,100	9500	833.22	744.38	833.22
Benzo(k)fluoranthene	ug/kg	1,100	6700	711.51	595.21	711.51
Benzo(a)pyrene	ug/kg	61 or MDL**	9000	876.03	702.87	876.03
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	4800	635.36	493.98	635.36
Dibenz(a,h)anthracene	ug/kg	14 or MDL**	2000	466.15	385.94	466.15
Benzo(g,h,i)perylene	ug/kg	50,000	5000	680.92	506.77	680.92
Pesticides/PCB's						
Aroclor-1260	ug/kg	1,000	340	161.11	141.39	161.11
Metals						
Cadmium	mg/kg	1.74	43.1	5.53	3.22	5.53
Chromium	mg/kg	26.49	62	30.55	28.34	30.55
Copper	mg/kg	25	836	71.55	69.80	71.55
Lead	mg/kg	30	2890	264.93	208.08	264.93
Zinc	mg/kg	88.89	55700	1,579.68	2,111.63	1,579.68

* NYSDEC TAGM values based on Technical and Administrative Guidance Memorandum HWR-92-4046, November 16, 1992. The TAGMs are TBCs and are for comparison purposes only.

** For semivolatile organic compounds the Minimum Detection Limit (MDL) is 330 ug/Kg.

TABLE 2-1 (cont.)

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SOIL ANALYSIS RESULTS (All Depths)
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL FEASIBILITY STUDY

COMPOUND	UNITS	NYSDEC TAGM*	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics						
Vinyl Chloride	ug/kg	200	14,500	62.47	172.65	62.47
1,2-Dichloroethene (total)	ug/kg	300	79,000	1,712.18	1,989.32	1,712.18
Trichloroethene	ug/kg	700	540,000	2,267.98	9,373.25	2,267.98
Semivolatiles						
2-Methylnaphthalene	ug/kg	36,400	3,600	441.35	393.12	441.35
Acenaphthylene	ug/kg	41,000	510	265.48	248.15	265.48
Dibenzofuran	ug/kg	6,200	7,000	397.55	373.26	397.55
Phenanthrene	ug/kg	50,000	43,000	657.71	882.10	657.71
Benzo(a)anthracene	ug/kg	220 or MDL**	9,600	520.48	531.23	520.48
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	230,000	714.92	2,050.95	714.92
Benzo(b)fluoranthene	ug/kg	1,100	9,500	498.22	513.04	498.22
benzo(k)fluoranthene	ug/kg	1,100	6,700	468.90	447.89	468.90
Benzo(a)pyrene	ug/kg	61 or MDL**	9,000	490.78	486.21	490.78
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	4,800	430.56	396.93	430.56
Dibenz(a,h)anthracene	ug/kg	14 or MDL**	2,900	410.55	367.55	410.55
Benzo(g,h,i)perylene	ug/kg	50,000	5,000	431.19	392.32	431.19
Pesticides/PCBs						
Aroclor-1260	ug/kg	1,000	770	157.24	143.06	157.24
Metals						
Cadmium	mg/kg	1.74	43.1	3.84	2.47	3.84
Chromium	mg/kg	26.49	62	27.72	26.73	27.72
Copper	mg/kg	25	836	40.46	43.64	40.46
Lead	mg/kg	30	2,890	90.05	115.46	90.05
Zinc	mg/kg	88.89	55,700	409.06	860.14	409.06

* NYSDEC TAGM values based on Technical and Administrative Guidance Memorandum HWR-92-4046, November 16, 1992. The TAGMs are TBCs and are for comparison purposes only.

** For semivolatile organic compounds the Minimum Detection Limit (MDL) is 330 ug/Kg.

TABLE 2-1 (cont)

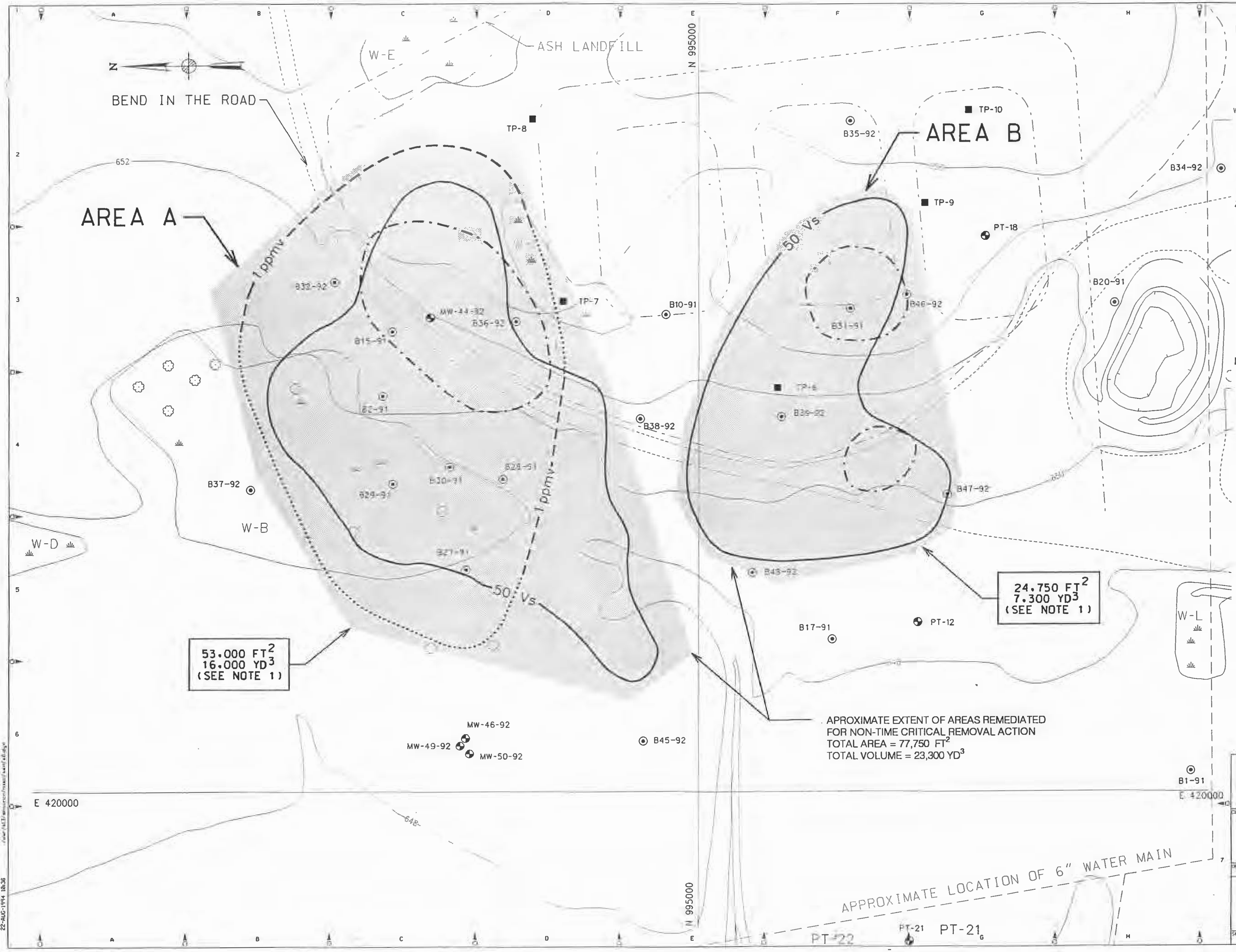
EXPOSURE POINT CONCENTRATIONS - CHEMICALS OF CONCERN
GROUNDWATER ANALYSIS RESULTS
VALIDATED ON-SITE DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC AWQS*	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration
Volatile Organics						
Vinyl Chloride	ug/L	2	23,000.00	59.81	648.56	59.81
1,2-Dichloroethene (total)	ug/L	5	130,000.00	845.01	2,656.02	845.01
1,1,1-Trichloroethane	ug/L	5	2,100.00	10.20	27.66	10.20
Trichloroethene	ug/L	5	51,000.00	605.60	1,431.20	605.60
Semi-volatiles						
2-Methylnaphthalene	ug/L	NA	13.00	5.58	5.38	5.58
Metals						
Aluminum	ug/L	NA	306,000.00	254,061.90	20,713.04	254,061.90
Cadmium	ug/L	10	64.60	3.09	3.03	3.09
Chromium	ug/L	50	418.00	62.23	31.04	62.23
Copper	ug/L	200	412.00	30.26	24.67	30.26
Lead	ug/L	25	147.00	21.10	10.76	21.10
Nickel	ug/L	NA	622.00	56.73	42.61	56.73
Zinc	ug/L	300	1,750.00	441.98	157.35	441.98

* NYSDEC AWQS for Class GA waters. From 6 NYCRR Parts 701-705.

	Federal MCLs (ug/L):	
Vinyl Chloride	2	
1,2-Dichloroethene	(cis) = 70; (trans) = 100	
1,1,1-Trichloroethane	200	
Trichloroethene	5	
2-Methylnaphthalene	NA	
Aluminum	NA	
Cadmium	5	
Chromium (total)	100	
Copper	1,300	(action level)
Lead	15	(action level)
Nickel	100	(being remanded))



LEGEND:

PAVED ROAD
DIRT ROAD
650 GROUND CONTOUR AND ELEVATION
TREE
W-B WETLAND & DESIGNATION
APPROXIMATE EXTENT OF FILL
OUTLINE OF FORMER REFUSE PITS (IDENTIFIED FROM AERIAL PHOTO)
PT-12 MONITORING WELL AND DESIGNATION
B17-91 SOIL BORING & DESIGNATION
TP-9 TEST PIT & DESIGNATION
1 ppmv SOIL GAS SURVEY CONTOUR FROM PHASE 1 REMEDIAL INVESTIGATION (DOTTED WHERE INFERRED)
50 Vs SOIL HEADSPACE SURVEY CONTOUR
ICF (1989) SOIL GAS SURVEY >100ug/L TOTAL VOLATILES

NOTES:

1. DEPTH OF EXCAVATION IS 8 FEET, WHICH IS THE AVERAGE DEPTH TO BEDROCK.

ES
ENGINEERING-SCIENCE, INC.

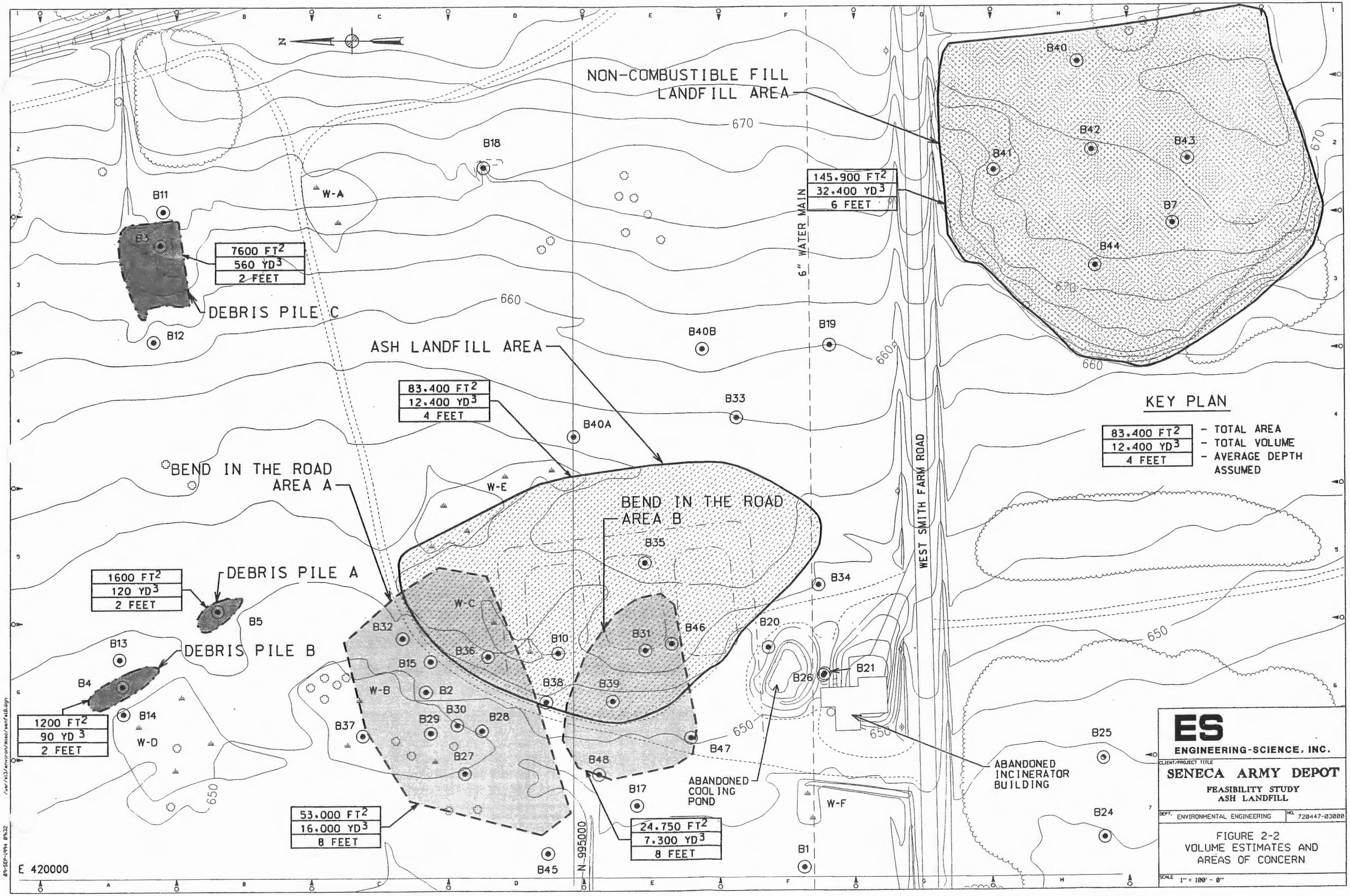
CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING
NO. 720447-03000

FIGURE 2-1
VOLUME ESTIMATE
FOR THE BEND-IN-THE ROAD

SCALE 1" = 50'

22-AUG-1994 18:36



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SENECA ARMY DEPOT
FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING
NO. 720447-03000

FIGURE 2-2
VOLUME ESTIMATES AND
AREAS OF CONCERN

SCALE 1" = 100' - 0"

Table 2 - 6

SENECA ARMY DEPOT
ASH LANDFILL
FEASIBILITY STUDY

AREAS FOR SOIL REMEDIATION

CASE	LOGIC	DESCRIPTION OF AREA TO BE REMEDIATED	TOTAL AREA-ft2	AVERAGE DEPTH	TOTAL VOLUME	SAMPLING LOCATIONS
1 Removal Action	Non-Time Critical Removal Action (RA) Completed - Volatile Organics Remediated	"Bend in the Road" - remediation completed				B2, B15, B27, B28, B29, B30, B31, B32, B36, B39, B46, B47, B48
		Area A	53,300	8.0	15,793	
		Area B	24,750	8.0	7,333	
					23,126	
				Cumulative Total	23,126	
2	High Semivolatiles and Metals	"Bend in the Road" plus Ash Landfill	83,400	4.0	12,356	B2, B10, B15, B20, B27, B28, B29, B30, B31, B32, B35, B36, B38, B39, B46, B47, B48
		(Includes Case 1(RA) above)		Cumulative Total	35,481	
3	High Semivolatiles and Metals	Debris Piles				B3, B4, B5, B11, B13, B14
		Pile A	1,600	2.0	119	
		Pile B	1,200	2.0	89	
		Pile C	7,600	2.0	563	
					770	
		(Includes Case 1(RA) and Case 2)		Cumulative Total	36,252	
4	High Semivolatiles and Metals	Non-Combustible Fill Landfill	145,900	6.0	32,422	B7, B40, B41, B42, B43, B44
		(Includes Case 1(RA), Case2 and Case 3)		Cumulative Total	68,674	

Table 2 - 7

SENECA ARMY DEPOT
ASH LANDFILL
SURFACE SOIL
COMPARISON TO NYSDEC TAGM VALUES FOR ALTERNATIVE REMEDIATION CASES

COMPOUND	NYDEC TAGM	BASELINE CASE			CASE 1 - REMOVAL ACTION			CASE 2			CASE 3			CASE 4		
		COUNT	Maximum	95 th UCL of the mean	COUNT	Maximum	95 th UCL of the mean	COUNT	Maximum	95 th UCL of the mean	COUNT	Maximum	95 th UCL of the mean	COUNT	Maximum	95 th UCL of the mean
Volatile Organics-ug/Kg																
Vinyl Chloride	200	52	750.00	16.02	35	7.50	6.20	32	7.50	6.21	26	7.00	6.14	20	7.00	6.23
Dichloroethene, 1,2- (total)	300	52	38,000.00	584.27	35	7.00	4.43	32	6.50	4.28	26	6.50	4.50	20	6.50	4.12
Trichloroethene	700	52	150,000.00	1,592.88	35	130.00	16.71	32	130.00	12.46	26	98.00	8.75	20	9.00	5.12
Semi-volatiles-ug/Kg																
Methylnaphthalene, 2-	36,400	53	1,250.00	360.05	53	1,250.00	360.05	32	1,250.00	412.58	26	1,250.00	413.82	20	450.00	371.32
Acenaphthylene	41,000	25	510.00	251.08	25	510.00	251.08	13	510.00	265.02	12	510.00	259.59	8	510.00	333.00
Dibenzofuran	6,200	53	1,400.00	407.83	53	1,400.00	407.83	32	1,400.00	480.11	26	1,250.00	444.56	20	450.00	371.32
Phenanthrene	50,000	53	15,000.00	1,047.87	53	15,000.00	1,047.87	32	15,000.00	1,798.27	26	15,000.00	1,275.91	20	1,700.00	496.48
Benzo(a)anthracene	220 or MDL	53	9,600.00	915.76	53	9,600.00	915.76	32	9,600.00	1,538.00	26	9,600.00	1,233.55	20	1,300.00	484.32
bis(2-Ethylhexyl)phthalate	50,000	53	230,000.00	987.69	53	230,000.00	987.69	32	230,000.00	2,022.99	26	230,000.00	2,891.14	20	650.00	430.65
Benzo(b)fluoranthene	1,100	53	9,500.00	833.22	53	9,500.00	833.22	32	9,500.00	1,341.30	26	9,500.00	980.35	20	740.00	416.38
Benzo(k)fluoranthene	1,100	53	6,700.00	711.51	53	6,700.00	711.51	32	6,700.00	1,069.38	26	6,100.00	852.82	20	870.00	431.85
Benzo(a)pyrene	61 or MDL	53	9,000.00	876.03	53	9,000.00	876.03	32	9,000.00	1,388.60	26	8,400.00	1,028.09	20	1,500.00	507.56
Indeno(1,2,3-cd)pyrene	3,200	53	4,800.00	635.36	53	4,800.00	635.36	32	4,800.00	936.06	26	4,600.00	764.02	20	660.00	385.73
Dibenzo(a,h)anthracene	14 or MDL	53	2,000.00	466.15	53	2,000.00	466.15	32	2,000.00	579.37	26	1,800.00	510.91	20	450.00	367.39
Benzo(g,h,i)perylene	50,000	53	5,000.00	680.92	53	5,000.00	680.92	32	5,000.00	961.60	26	4,000.00	800.93	20	880.00	413.72
Pesticides/PCB's-ug/Kg																
Arochlor-1260	1,000	53	340.00	161.11	53	340.00	161.11	32	220.00	163.78	26	220.00	154.25	20	220.00	169.76
Metals-mg/Kg																
Cadmium	1.74	53	43.10	5.53	53	43.10	5.53	32	43.10	8.05	26	8.20	2.58	20	8.20	2.85
Chromium VI	26.49	53	62.00	30.55	53	62.00	30.55	32	62.00	34.55	26	48.60	30.30	20	35.00	28.41
Copper	25	53	836.00	71.55	53	836.00	71.55	32	836.00	102.29	26	177.00	45.72	20	52.10	30.35
Lead (1)	500	48	2,890.00	264.93	48	2,890.00	264.93	27	2,890.00	764.26	21	1,170.00	113.22	15	40.20	24.96
Zinc	88.89	53	55,700.00	1,579.68	53	55,700.00	1,579.68	32	55,700.00	2,419.17	26	745.00	205.64	20	335.00	142.32

Note: Case 1- Removal Action has been completed.
(1) The criteria for lead is site-specific.

12/12/96

Table 2-8

SENECA ARMY DEPOT
ASH LANDFILL
FEASIBILITY STUDY

RISK ASSESSMENT FOR ALTERNATIVE AREAS OF SOIL REMEDIATION

CASE	EXPOSURE SCENARIO	SOIL REMEDIATION QNTY - yds3	HAZARD INDEX					CARCINOGENIC RISK				
			SOIL INGESTION	SOIL DERMAL	AIR PATHWAY	OTHER PATHWAYS	TOTAL SITE HI	SOIL INGESTION	SOIL DERMAL	AIR PATHWAY	OTHER PATHWAYS	TOTAL SITE RISK
BASELINE	CURRENT AND INTENDED FUTURE SITE USE	0	1.0E-02	5.9E-02	2.1E-02	1.5E-01	0.2437	2.1E-06	1.4E-06	7.2E-05	2.4E-05	1.00E-04
1- RA (completed)	CURRENT AND INTENDED FUTURE SITE USE	23,126	1.0E-02	5.9E-02	7.4E-04	1.5E-01	0.2229	2.1E-06	1.4E-06	8.2E-07	2.4E-05	2.86E-05
2	CURRENT AND INTENDED FUTURE SITE USE	35,481	1.2E-02	8.4E-02	7.4E-04	1.5E-01	0.2493	2.5E-06	1.5E-06	8.2E-07	2.4E-05	2.91E-05
3	CURRENT AND INTENDED FUTURE SITE USE	36,252	7.9E-03	3.0E-02	8.1E-04	1.5E-01	0.1911	2.3E-06	1.4E-06	7.9E-07	2.4E-05	2.87E-05
4	CURRENT AND INTENDED FUTURE SITE USE	68,674	7.5E-03	3.3E-02	8.1E-04	1.5E-01	0.1934	1.7E-06	1.5E-06	7.9E-07	2.4E-05	2.83E-05

Note:
1) RA = the Non-time critical removal action (Case 1) has already been completed.

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removed and treated. This removal is described in Section 1.6. The primary goal of the removal action was to remove the source of groundwater contamination. An additional goal was to reduce site risks for current and intended future use scenarios.

As shown in Table 2-8, this removal action significantly reduced the 95th UCL of the mean concentration of the volatile constituents at the site. The overall cancer risk posed by the soils at the site will be reduced, from 1.0×10^{-4} to 2.9×10^{-5} due primarily to elimination of the inhalation exposure pathway (Table 2-9).

Post prove-out soil samples were collected and analyzed for the TCLP (metals) from the treated soils representative of Areas A and B. The TCLP metal analytical data presented in Appendix E of this report indicate that the maximum concentration of lead was 814 mg/kg in one sample. The remaining concentrations of lead ranged from 4.4 mg/kg to 401 mg/kg, which are below the site-specific remediation goal of 500 mg/kg.

Case 2 addresses the portions of the Ash Landfill not addressed by Case 1, the removal action. The entire Ash Landfill would be excavated to a depth of 4 feet, for a volume of 12,356 cubic yards, considering the approximately 23,000 cubic yards already excavated and treated for the removal action. The primary goal of Case 2 is to remove the soils with elevated levels of metals and semivolatile organic compounds present in the Ash Landfill. The effect of Case 2 on the 95th UCL concentration of the mean is shown in Table 2-8, and the effect on the cancer risk is shown on Table 2-9, however, these tables are somewhat misleading. Since a large number of data points are eliminated when Case 2 is implemented, the high remaining concentrations skew the mean value. Therefore, Tables 2-8 and 2-9 indicate a slight increasein the 95th UCL concentration and the cancer risk, even though a substantial amount of soil has been removed. These values are dependent on the mean of the actual data points and do not account for the actual volume of the contaminated soil. The maximum lead concentration for soil is 2890 mg/kg, which is above the established clean-up goal of 500 mg/kg.

Case 3 addresses the soils in Debris piles A, B, and C. The total volume of these three piles is 770 cubic yards, which brings the cumulative volume of all soils from the removal action (Case 1) and cases 2 and 3 to 36,252 cubic yards. Table 2-8 summarizes the effect of Case 3 on the 95th UCL concentration. There are substantial decreases in the metals concentrations, and smaller decreases in the organic concentrations. The maximum concentration of lead is decreased to 1179 mg/kg, which is above the soil clean-up level of 500 mg/kg. The cancer risk, shown in Table 2-9 also

decreases slightly. Again, the cancer risk is primarily driven by the PAHs, whose 95th UCL concentration is based more on one-half the detection limit and one or two detects, rather than the prevalence of these compounds.

Case 4 addresses the NCFL, the area with the majority of the remaining elevated metal and semivolatile concentrations. The volume included in Case 4 is 34,422 cubic yards, which assumes a depth of 6 feet. The total volume of soil addressed by the removal action (Case 1) and the other three proposed cases is 68,674 cubic yards. Table 2-8 summarizes the changes in the 95th UCL concentration, and Table 2-9 shows the decrease in the cancer risk. While the concentrations shown in Table 2-8 decrease significantly, they do not drop below the NYSDEC TAGM value for a number of PAH compounds. However, as shown in Table 2-9, the cancer risk drops to 2.83 X 10^{-5}, which is well below the 1 X 10^{-4} EPA threshold. In addition, the maximum lead concentration is decreased to 40.2 mg/kg, which is below the site-specific cleanup level for lead in soil.

2.4.2 Groundwater

ARAR-based limits are the principal cleanup criteria for groundwater. New York has promulgated Class GA ambient water quality standards which apply to the groundwater at the Ash Landfill. These limits are shown on Table 2-2.

The volume of contaminated groundwater was estimated to be 9.9 million gallons. This is the quantity of water present at the site within the estimated boundaries of the organic plume. The actual volume treated over the course of the remedial action would likely be much greater under a pump-and-treat scenario. Preliminary estimates (Appendix A) indicate that 4 to 8 years would be the treatment time necessary to reduce the groundwater concentration in the plume to the NYSDEC Class GA standards since the soils removal action was completed; 30 to 40 years would have been required if it had not been completed. Assuming the maximum sustainable treatment flow would be 20 to 25 gpm, the total volume of groundwater that would be treated in 4 to 8 years is estimated to be 52 to 64 million gallons (13 million gallons per year) compared to a volume of 390 to 520 million gallons that would have resulted from 30 to 40 years of sustained treatment flow. However, it is unlikely that this flow would be sustainable throughout the year since field data indicate large groundwater fluctuation occurring at the site. At dry portions of the year the flow will likely be one-tenth of the upper limit.

The mass of the contaminants of concern in the groundwater was also estimated. Over time, the concentration of each contaminant of concern would decrease, and the volume of water treated to obtain a unit mass decrease of each contaminant of concern would increase. An accurate estimate of the mass of each compound will help provide an estimate of the time required for treatment. The two primary constituents of concern in the groundwater at the Ash Landfill are TCE and 1,2-DCE. There are approximately 583 pounds in the groundwater, with an additional 108 pounds in the soil.

2.5 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.5.1 Identification of Technologies

Remedial action technologies and processes have been identified for consideration as possible remedial options at the Ash Landfill. The list of technologies and processes presented below was developed from several sources:

- Standard engineering handbooks
- Vendors information
- Best engineering estimates
- EPA references:

-"Handbook on In Situ Treatment of Hazardous Waste - Contaminated Soils" (EPA 1990)
-"Handbook on Remediation of Contaminated Sediments" (EPA 1991)
-"The Superfund Innovative Technology Evaluation Program" (EPA 1992)
-"Vendor Information System for Innovative Treatment Technologies" (EPA 1993)

Table 2-10 shows the remedial action processes arranged according to categories for general response actions for source control (remediation of soil/sediment). Table 2-10 also shows which technologies/processes were retained for further evaluation in Section 3.0 and provides the basis for screening out the various technologies/processes. Table 2-11 is arranged in similar fashion for groundwater remedial technologies.

Because the non-time critical removal action has been performed, and has successfully treated the source of VOCs in soils near the "Bend in the Road", source control remedial action technologies discussed in this FS will not include treatment for VOCs.

TABLE 2-9
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION (SOURCE CONTROL)

SOIL/ SEDIMENT GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
No Action	None	Time	No Action.	Applicable. Required as baseline response for comparison to other technologies.
Institutional controls	Access Control	Fencing, Security	Access to Ash Landfill restricted by security force at access points. Perimeter patrolled daily.	Applicable. Effective in reducing and eliminating human exposure. Dependent on the U.S. Government's continued ownership:
		Wall and posting	Access to Ash Landfill is restricted by construction of a permanent, low-maintenance wall. Warning signs posted.	Applicable. Effective in reducing human exposure. Permanence dependent on design and materials of construction.
		Deed restrictions	Deed for property modified to restrict future sales and land use, or U.S. Government holds deed into perpetuity.	Applicable. Army Regulations require notification and clean-up consistent with intended future land use. If restricted land use is included in a land transfer, the future land use will be determined at the time of transfer.
	Monitoring	Soil Monitoring	Periodic sampling soils. Monitors changes in extent of soil/sediment affected by constituents.	Not Applicable. Not necessary because the condition of the Ash Landfill source area is not expected to change significantly in the near future.
	Alternative Water Supply	City water line or bottle water	Extend city supply line to area or provide trucked in water.	Not Applicable. No current drinking water supply is affected.
Containment	Horizontal barriers	Soil cap	Consolidate all wastes into the Non-Combustible Fill Landfill as required to meet existing grade. Place two to five feet of clean fill on entire landfill, grade and seed.	Applicable. Will only be appropriate for non-volatile organics and metals, effective in restricting future residential exposure and eliminating transport due to surface water erosion.
		Clay cap	Add one to two foot clay layer beneath soil cap.	Applicable. Same comments as with the soil cap long term monitoring required but more effective in minimizing infiltration.
		Asphalt cap	Highway-grade base and asphalt pavement over entire Ash Landfill.	Not appliicable. Not as reliable as a clay or soil cap, high maintenance.

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TABLE 2-9
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION (SOURCE CONTROL)
(Cont.)

SOIL/ SEDIMENT GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
Containment (cont)	Vertical barriers	Sheet pile	Steel barrier wall driven into soil in sections using a drop-hammer or vibrating hammer.	Applicable. This is a migration control technology. It may be used to minimize groundwater inflow to excavation during source control activities.
	Vertical barriers	Slurry wall	Trench around affected area and fill trench with cement/bentonite or soil/bentonite slurry.	Applicable. This could be used to minimize groundwter flow into excavation.
		Grout Curtain	Pressure injection of grout in a regular pattern of drill holes.	Not applicable. Not as effective in low-permeability soils as slurry wall. Typically used if other treatment alternatives cannot be used.
		Vibrating beam	Drive steel beam into ground and inject slurry as beam is withdrawn.	Not applicable. Not as effective as slurry wall. Typically used if other treatment alternatives cannot be used.
In Situ Treatment	Solidification	Pozzolan-portland cement	Pozzolan mixed with soil/sediment using auger type mechanism.	Applicable. Effective in meeting remedial objectives for metals, and non-volatile organics, less effective if matrix contains high oil content.
		Pozzolan-lime/flyash	Pozzolan mixed with soil/sediment using auger type mechanism.	Applicable. Effective in meeting remedial objectives for metals, and non-volatile organics, less effective if matrix contains high oil content.
		Vitrification	Additives mixed into soil, electrodes placed in-ground and energy applied to electrodes. Soil/sediment and additives form molten glass that cools to a stable non-crystalline solid.	Not Applicable. Landfill debris can cause poor formation of melt. Innovative technology with some successfull applications but not used widely.
	Extraction	Soil flushing	Constituents are extracted using surfactants, solvent (polar or non-polar) or hotwater.	Not Applicable. Not effective in meeting remedial objectives for metals and semi-volatiles. Low soil permeability will restrict effectiveness. Requires wastewater treatment plant and/or solvent recovery process.

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TABLE 2-9
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION (SOURCE CONTROL)
(Cont.)

SOIL/ SEDIMENT GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
In Situ Treatment (con't)	Biological	Biodegradation	Cultivate microbes to degrade constituents by controlling moisture content, oxygen, pH, nutrients and temperature. Groundwater or air is recycled through the contaminated soil mass.	Not Applicable. Does not address all site contaminants. Not effective for metals, chlorinated organics and high molecular weight Polynuclear Aromatic Hydrocarbons. Soil permeability will restrict effectiveness. May require treatment plant for extracted groundwater or air prior to reinjection.
Removal	Excavation	Earthmoving/Excavation	Wheeled, bulk scraper, removes surficial or subsurficial soil into storage compartment.	Applicable. Effective. Used for relatively large quantities of soil.
Ex Situ Treatment	Biological	Aerobic	Microbes cultivated to degrade constituents under aerobic conditions. Includes composting, land farming and slurry reactors.	Not Applicable. Not effective for metals, chlorinated organics or high molecular weight Polynuclear Aromatic Hydrocarbons (PAHs).
		Anaerobic	Microbes cultivated to degrade constituents under anaerobic conditions, typically an in-vessel process.	Not Applicable. Not effective for metals
	Physical- Solidification	Pozzolan-portland cement	Pozzolan mixed with soil/sediment using auger type mechanism.	Applicable. Effective for metals and semi-volatile organics.
		Pozzolan-lime/flyash	Pozzolan mixed with soil/sediment using auger type mechanism.	Applicable. Effective in meeting remedial objectives. Refer to portland cement process of solidification.
	Physical- Solidification (con't)	Micro-encapsulation	High density polyethylene is mixed with soil/sediment to form plastic frit.	Applicable. Effective in meeting remedial objectives. Refer to portland cement process of solidification.
	Physical-Separation	Washing (wet separation)	Mix soil/sediment with water and wet-classify soil particles by size and density. Includes dry screening (grizzly, vibratory, trammel), attrition scrub, hydrocyclones, flotation, water treatment/recycle.	Applicable. Volume reductions achieved. Innovative technology: treatability study required. Effective when used in conjunction with another technology such as acid leaching, solidification or off-site landfilling.

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LE 2-9
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION (SOURCE CONTROL) (Cont.)

SOIL/ SEDIMENT GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
Ex Situ Treatment (cont)		Magnetic classification	Soils subjected to magnetic field to remove ferrous metals.	Not Applicable. No appreciable quantities of ferrous metals.
	Oxidation-thermal	High temperature processes	Includes: electric reactor, fluid bed incinerator, molten salt, multi-hearth incinerator, rotary kiln incinerator, plasma arc incinerator and catalytic incinerator.	Applicable. Effective for most organic constituents. Not effective for removing heavy metals.
	Oxidation-other	Supercritical	Soil mixed with water and excess air under supercritical pressure and temperature.	Not Applicable. Not a proven technology. Heavy metals are not removed.
		Chemical	Oxidizing agent such as hydrogen peroxide or potassium permanganate solution mixed into soil.	Not Applicable. Not a proven technology.
		Microwave plasma	Microwave frequency electromagnetic radiation applied to soil.	Not Applicable. Not a proven technology.
	Chemical-extraction	Supercritical extraction	Constituents extracted in countercurrent process using carbon dioxide, propane or other highly volatile solvent under supercritical temperature and pressure conditions. Solvent is separated from extracted constituents (flashed or distilled) and recycled.	Not Applicable. Not effective in removing heavy metals. Site Demonstration report indicates PAH removals of 80 to 99% can be achieved. Sizing of materials is required. All materials must be less than 1/8 inch. High pressure (up to 300 psi) vessels are required. Costly for small volumes ($300 to $600/ton).
		Aqueous solvent	Constituents extracted using aqueous solvent such as acid, base, salt or surfactant solutions. Extracted soil is rinsed. Solvent and rinsewater treated and recycled.	Not Applicable. Volume reduction achieved. Acid extraction effective for metal removal. Technology is used in mining operations: treatability study required.

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LE 2-9
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION (SOURCE CONTROL)
(Cont.)

SOIL/ SEDIMENT GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
	Chemical-extraction (cont)	Amine Extraction	Constituents extracted using secondary or tertiary amines, usually triethyl amine (TEA). TEA is completely soluble in water below 20°C. Seperation of TEA from solids are achieved by gravity and centrifuging. TEA is seperated from water by heating causing the TEA to be insoluble. TEA is recycled by distillation, leaving the extracted organics, usually an oily sludge. The sludge is then incinerated.	Not Applicable. Not effective for heavy metals. Volume reduction achieved, final extracted organic material requires additional final treatment. Material sizing to less than 1/4 inch as required prior to processing.
Disposal	Solids Handling	Backfill on-site	Reuse of treated soil as backfill in excavated areas.	Applicable.
		Subtitle D landfill	Disposal of soil that has been treated to remove toxicity hazard. Local or regional landfill, that accepts industrial solid waste (off-site or constructed on-site)	Applicable. Must comply with EPA Subtitle D and 6 NYCRR Part 360 requirements. Groundwater monitoring required.
		RCRA Landfill	Disposal of soil, treated to remove toxicity hazard, in a RCRA hazardous waste landfill (off-site).	Not Applicable. Required for RCRA listed and characteristic hazardous waste. RCRA groundwater monitoring required.

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TABLE 2-10
TECHNOLOGY SCREENING FOR GROUNDWATER REMEDIATION (MIGRATION CONTROL)

GROUNDWATER GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
No-Action	None	Time	No Action.	Applicable. Required as baseline response for comparison to other technologies. Does not meet all remedial action objectives.
Institutional controls	Access Control	Fencing, Security	Access to Ash Landfill restricted by security force at access points. Perimeter patrolled daily.	Applicable. Effective in reducing and eliminating human exposure. Dependent on the U.S. Government's continued ownership: does not meet all remedial action objectives.
		Wall and posting	Access to Ash Landfill is restricted by construction of a permanent, low-maintenance wall. Warning signs posted.	Applicable. Permanence dependent on design and materials of construction. Does not meet all remedial action objectives.
		Deed restrictions	Deed for property modified to restrict future sales and land use, or U.S. Government holds deed into perpetuity.	Applicable. May not restrict future resident exposure.
	Monitoring	Groundwater monitoring	Periodic sampling of groundwater to monitor changes in the extent of migration of potentially hazardous constituents.	Applicable. Does not meet all remedial action objectives.
	Alternative Water Supply	City water line or bottle water	Extend city supply line to area or provide trucked in water.	Applicable. Does not meet all remedial action objectives.
Containment	Horizontal barriers	Soil cap	Place two to five feet of clean fill on affected areas of Ash Landfill site, grade and seed.	Not Applicable. Does not eliminate infiltration.
		Clay cap	Add one to two foot clay layer beneath soil cap.	Not Applicable. Not completely effective in reducing infiltration and recharge. The size of the cap would be too large.
		Asphalt cap	Highway-grade base and asphalt pavement over affected areas of Ash Landfill.	Not Applicable. Not permanent, high maintenance.

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TABLE 2-10
TECHNOLOGY SCREENING FOR GROUNDWATER REMEDIATION (MIGRATION CONTROL) (Cont.)

GROUNDWATER GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
Containment (cont.)	Vertical barriers	Sheet pile	Steel barrier wall driven into soil in sections using a drop-hammer or vibrating hammer.	Applicable. Not as cost-effective as slurry walls at shallow depths. May be used in conjunction with source control technology.
		Slurry wall	Trench around affected area and fill trench with cement/bentonite or soil/bentonite slurry.	Applicable. Very effective at shallow depths.
		Grout curtain	Pressure injection of grout in a regular pattern of drill holes.	Not Applicable. Not as effective as slurry walls.
		Vibrating beam	Drive steel beam into ground and inject slurry as beam is withdrawn.	Not Applicable. Not as effective as slurry walls.
Diversion	Vertical Barriers	Slurry wall	Trench around affected area and fill trench with cement/bentonite or soil/bentonite slurry.	Not Applicable. Slurry wall diversion not as effective as containment.
		Grout curtain	Pressure injection of grout in a regular pattern of drill holes.	Not Applicable. Grout curtain diversion not as effective as containment.
		Vibrating beam	Drive steel beam into ground and inject slurry as beam is withdrawn.	Not Applicable. Vibrating beam diversion not as effective as containment.
		Interceptor trench	A trench is dug downgradient of the groundwater plume to divert the groundwater.	Not Applicable. Interceptor trench diversion not as effective as collection.
Collection	Collectors Vertical	Interceptor trench	A trench is dug downgradient of the groundwater plume to collect the groundwater.	Applicable. Very effective at shallow depths.

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TABLE 2-10
TECHNOLOGY SCREENING FOR GROUNDWATER REMEDIATION (MIGRATION CONTROL)
(Cont.)

GROUNDWATER GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
Collection (cont.)	Collectors Vertical (cont.)	Collector wells	Several wells are set up to capture the groundwater.	Not Applicable. Numerous wells required due to tight soils and small radius of influence. Not cost-effective.
In Situ Treatment	Biological	Aerobic	Cultivate microbes in aquifer to degrade constituents by controlling pH, and supplying oxygen and nutrients.	Not Applicable. Unfavorable subsurface conditions.
		Anaerobic	Cultivate microbes in aquifer to degrade constituents by controlling pH, and supplying oxygen and nutrients.	Not Applicable. Unfavorable subsurface conditions.
		Air sparging	Treatment combines in situ air stripping with aerobic biodegradation	Applicable. Technology that works well for volatile organics, however, tight soils may limit its effectiveness.
On Site Treatment	Biological	Aerobic biodegradation (Activated sludge)	Cultivate aerobic microbes to degrade constituents by controlling oxygen, pH, nutrients and temperature.	Not Applicable. Not effective for contaminants of concern and concentrations present. (low F/M ratio)
		Anaerobic biodegradation	Cultivate methanogenic microbes to degrade constituents by controlling oxygen, pH, nutrients and temperature.	Not Applicable. Not effective for contaminants of concern and concentrations present (low F/M ratio).
		Landfarming/spray irrigation	Promotes aerobic biodegradation by mixing the groundwater with soil, and controlling moisture, nutrients, and pH.	Not Applicable. Does not provide adequate controls for air emissions of volatile organic compounds. Not effective for contaminants of concern and concentrations present.

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TABLE 2-10
TECHNOLOGY SCREENING FOR GROUNDWATER REMEDIATION (MIGRATION CONTROL)
(Cont.)

GROUNDWATER GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
On Site Treatment (cont.)	Biological (cont.)	Two-stage anaerobic/ aerobic reactor	Two step anaerobic biological dechlorination followed by aerobic oxidation using either fluidized bed or solid-phase fixed-film reactor.	Applicable. Innovative technology. Present research indicates that this technology is effective in removing dissolved chlorinated organics. Commercial systems are available through vendors. Pilot testing may be necessary.
	Physical/chemical	Reverse osmosis	Membrane separation is used to remove organic and inorganic contaminants.	Not Applicable. Not a proven technology for chlorinated solvents in groundwater.
		Ultraviolet Oxidation	Organics are treated with a combination of UV light and an oxidizing agent (ozone or peroxide)	Applicable. Technology that works well for volatile organics.
		Reduction	Heavy metals are treated by inducing electrochemical reactions	Not Applicable for chlorinated organics.
		Neutralization	Metal hydroxide formed form dissolved species and settled-out of solution.	Not Applicable for chlorinated organics.
		Hydrolysis	Water and caustic are used to destroy organic contaminants.	Not Applicable. Effectiveness for chlorinated solvents not demonstrated.
		Wet air oxidation	Heat and pressure are used to degrade waste.	Not Applicable. Effectiveness for chlorinated solvents not demonstrated.
		Supercritical water oxidation	Organics are oxidized in a reactor using supercritical water as the oxidizing medium.	Not Applicable. Impractical, not cost-effective.

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TABLE 2-10
TECHNOLOGY SCREENING FOR GROUNDWATER REMEDIATION (MIGRATION CONTROL)
(Cont.)

GROUNDWATER GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
On Site Treatment (cont)	Physical/chemical (cont)	Ion exchange	Aqueous solvent or rinsewater exposed to cationic and/or anionic resin bed where constituents are exchanged (captured on resin surface) with other species. Resin is regenerated.	No Applicable. Not effective for chlorinated organics.
		Air stripping	Organics are removed by transfer to the air phase.	Applicable. Effective for highly volatile compounds. Not effective for metals removal. Iron and Calcium can cause column fouling due to accumulation of oxide precipitation and growth of an iron consuming bacterial slime.
		Steam stripping	Organics are removed by transfer to steam phase.	Not Applicable.
		Distillation	Groundwater is heated, and the organics are driven off and collected.	Not Applicable.
		Precipitation/coagulation/ flocculation	Various reagents are used to induce settling of particulates in the groundwater.	Applicable. This technology works well for separation of particulates and groundwater.
		Sedimentation/clarification/ gravity thickening	Separates water from metal hydroxide solids.	Not Applicable.
		Hardness Removal	Removes calcium and other minerals from groundwater.	Applicable. May be used to reduce hardness of water for organic treatment processes.
		Filtration	Particulates are removed from the groundwater.	Applicable. Filtration will be used to remove silt and precipitate metals prior to the organic treatment.
		Carbon adsorption - liquid phase	Solution exposed to activated carbon bed for removal of dissolved organic constituents. Carbon thermally regenerated with off-gas treatment.	Applicable. Effective in treating chlorinated volatile organics.

☐ = screened

☐ = retained

TABLE 2-10
TECHNOLOGY SCREENING FOR GROUNDWATER REMEDIATION (MIGRATION CONTROL) (Cont.)

GROUNDWATER GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS	DESCRIPTION	SCREENING COMMENTS
On Site Treatment (cont.)	Physical/chemical (cont)	Carbon adsorption - vapor phase	Off-gas from air stripping unit is passed through carbon to remove organics from the air stream.	Applicable. Used in conjunction with other migration control technologies. Its purpose is to treat the off-gas to minimize air emissions.
		Mechanical aeration	Aerators are used to transfer oxygen to the groundwater. Aeration also promotes the removal of volatile organics.	Not Applicable. Requires air emission controls and is not as effective as air stripping.
Treated water disposal	SPDES Permit	Surface water	Discharge treated wastewater to drainage ditch, with eventual flow to Kendaia Creek.	Applicable. Requires SPDES permit.
		Groundwater	Reinject treated groundwater at site.	Applicable. However, may cause plugging of soils. Tight soils minimize infiltration potential.
		SEDA POTW	Collect treated wastewater in tank truck, transport to on-site wastewater treatment plant and discharge.	Requires excessive trucking of treated water, or installation of extensive piping. No sewer is located near Ash Landfill.
	Reinjection	Groundwater	Treated water is reinjected via a leach field.	Applicable. This is likely to be more effective than straight reinjection, but, again, the tight soils minimize the infiltration potential.

2-10new.tbl

☐ = screened

☐ = retained

2.5.2 Screening of Technologies for Source Control

Remedial action technologies and processes are screened on Table 2-10, based on whether a process is technically feasible and effective for remediating soils/sediment and whether it meets the remedial action objectives. As shown on Table 2-10, processes that are shaded have been screened out based on screening comments listed.

The following remedial technologies and processes were retained for further evaluation as source control alternatives:

- Access control: fencing, wall and posting, deed restrictions
- Horizontal barriers: capping,
- Vertical barriers: sheet pile, slurry wall,
- Excavation: earthmoving/excavation,
- Solidification: Pozzolan - portland cement/Pozzolan - lime flyash
- Physical separation: washing (wet separation)
- Solids handling: off-site disposal (RCRA landfill)
- Solids handling: Subtitle D landfill

2.5.2.1 No Action

The No Action response may be appropriate for source areas where natural environmental mechanisms will result in degradation or immobilization of the constituents or concern where the risks are acceptable. Although this remedial action will not meet the RAOs for source control, this response provides the baseline against which other responses can be compared.

2.5.2.2 Institutional Control Technologies

Institutional control technologies that have been considered includes:

- Access Controls, such as fencing, wall and posting, and deed restriction;
- Monitoring of soil; or
- Alternative water supply.

Institutional control technologies are only applicable to the receptor and do not involve reductions in the volume, toxicity or control of wastes at the site.

Physical barriers that restrict access to the site are feasible and effective in preventing humans from becoming exposed to on-site impacts. There are a number of access controls that are currently in place at the Ash Landfill, and that may be part of any long-term solution. Access to the site is limited by a fence that surrounds the entire depot and this area is also patrolled 24 hours by security guards. Although not currently in place, access to the site could be further restricted by constructing a permanent wall with warning signs posted.

Another type of access control is deed restriction. Specifically, this could be used to indicate that no drinking water wells should be constructed at the site.

Since the condition of the source area is not expected to change significantly, soil sampling/monitoring is not required. As a result, the use of soil monitoring was eliminated from further consideration.

Providing an alternative water supply to affected populations is also technically feasible and effective when implemented but in this instance this technology is unnecessary since the on-site groundwater is not a source of potable water. This technology was considered since off-site residences adjacent to the Ash Landfill do obtain water from private wells. Alternative water supply will be considered as a migration control technology.

2.5.2.3 Containment Technologies

Horizontal Barriers: Capping

Three types of caps were considered in this evaluation. These include caps comprised of :

- Soil,
- Clay, and
- Asphalt.

Capping in-place involves leveling and grading the NCFL or the Ash Landfill, placing an impermeable cap over the area and placing a protective soil cap over the impermeable layer. The engineered cap will provide provisions to minimize erosion, control surface water runoff/runon, gas

venting if required, and long term groundwater monitoring in accordance with the requirements of 6 NYCRR Part 360.

A third option for capping is an asphalt cap which involves constructing a cap of highway-grade base and asphalt pavement over the entire site. The asphalt cap is considered less reliable than the clay or soil cap and requires more maintenance. Therefore, this cap was eliminated.

Vertical Barriers

Vertical barriers involve preventing interaction between groundwater and buried wastes by surrounding the waste materials with an impermeable vertical wall. Four process operations for vertical walls were considered and include:

- Steel Sheet Pilings,
- Slurry Walls
- Grout Curtains, and
- Vibrating Beam.

Of the four vertical technologies considered, only slurry walls and sheet piles were retained for combination as a remedial alternative since these technologies were considered to be most effective for preventing groundwater flow. An inherent drawback of grouting is the indefinite extent and integrity of the final grout curtain that is created. Slurry walls are the most reliable and have numerous applications in the field of hazardous waste remediation.

2.5.2.4 In-Situ Treatment Technologies

The following in-situ treatment technologies were considered as potential remedial alternatives :

- Solidification Technologies
    - Cement-based Immobilization/Fixation
    - Vitrification

- Chemical Extraction Technology
    - Soil Flushing,

- Biological Extraction Technologies
    - Biodegradation

Although the Ash Landfill is not severely impacted with heavy metals, there are several solidification/stabilization technologies that may be feasible for remediation, pending treatability testing (refer to Section 4.0). For the purposes of this report, Portland cement will be used as a typical solidification technology because it is one of the more standard approaches. Solidification/Stabilization is a process in which the waste material is mixed with; water, pozzolanic material such as Portland cement, and proprietary additives. Lime or fly ash are typical stabilization reagents that may be added. The treated waste material is allowed to solidify into a specific block-size having significant unconfined compressive strength, physical stability and rigid, cement-like texture. This process decreases constituent mobility by binding constituents into a leach-resistant, concrete-like matrix while increasing the waste material volume by approximately 50%. Solidification is expected to be completed at 75 ton/hour (tph) or about 50 cy/hr.

Solidification may be performed either on-site or off-site. For the purpose of cost estimating off-site solidification was proposed to be completed at a Resource Conservation and Recovery Act (RCRA) treatment, storage, disposal facility (TSDF) either 220 miles east of the site or 180 miles west of the site (pending bid evaluations).

The vitrification process is considered innovative but has been identified as an appropriate technology for application at hazardous and radioactive waste sites. Full scale, widespread, operation of this technology has not been performed, probably due to the excessive power requirements that this technology requires, although pilot demonstration testing has been conducted. Geosafe Corp. successfully demonstrated this process at a site in Region V.

This technology was not retained for further consideration since the site conditions are not ideal for application of this technology. The thin zones of soil are not sufficiently thick to allow proper installation of the electrodes.

Soil flushing has promise at heavily contaminated sites where excavation is impractical but was eliminated from further consideration for application at the Ash Landfill since this technology is most appropriate for use with sites impacted with organic compounds. The constituents of concern at the Ash Landfill are inorganic compounds and semi-volatile compounds, and it is unlikely that any useable soil flushing agent would be successful at extracting the metals of interest. Further,

the low permeability of the soil suggests that the collection of the extracted materials would be slow and inefficient.

Biodegradation is not effective for inorganic components, chlorinated organics, and PAHs, and therefore has been eliminated from further consideration.

Of the technologies considered in the in-situ treatment general response category, only solidification was retained for consideration.

2.5.2.5 Removal Technologies

Since the soil at the Ash Landfill can be easily removed using standard mechanical excavation techniques, this technology was retained for further consideration.

Excavation and removal consists of excavation using an excavator. A bulldozer may be used if necessary, to loosen the shale fill prior to loading into dumper trucks for on-site or off-site hauling. Loading will be done using one or two 5-cy bucket front-end loaders. The production rate is estimated to be 150 cy/hr/loader (225 ton/hr/loader).

On-site hauling is estimated to be done at a rate of 100 cy/hr/dumper truck. Off-site hauling to a Subtitle D landfill is estimated to be done at a rate of 40 cy/day/truck (60 ton/day/truck).

2.5.2.6 Ex-situ Treatment Technologies

The following technology types and process options were determined to be applicable based on the screening criteria:

- Biological Technologies
  - Aerobic
  - Anaerobic

- Stabilization/Solidification Technologies
  - Pozzolan-portland cement
  - Pozzolan-lime-fly ash
  - Micro-encapsulation

- Physical Separation Technologies
    - Soil Washing
    - Magnetic Classification

- Thermal Oxidation Technologies
    - High Temperature Processes

- Other Oxidation Technologies
    - Supercritical
    - Chemical
    - Microwave Plasma

- Chemical Extraction Technologies
    - Supercritical Fluids
    - Aqueous Solvents
    - Amine Extraction

Ex-situ biological treatment of soil has been screened out since it is effective for soils that have been impacted with organic constituents and would not meet the objectives for reducing the concentration of metals in soil. Biological treatment would have little if any effect on the soils at the Ash Landfill that are impacted with metals.

The S/S technology using a mixture of pozzolan/cement/lime/fly ash has been identified by EPA as effective and is feasible for treatment of the soils at the Ash Landfill. The EPA policy regarding the use of this technology indicates that it is appropriate for materials that contain inorganics and non-volatile organics. With the wide range of solidifying agents available, this technology usually requires the performance of a site-specific treatability study to determine the most effective solidifying agent and the optimal ratio of waste to admixture. Since the constituents of concern at the site are inorganics with some amounts of semi-volatile organics, such as PAHs, this technology meets the requirements for application at this site and was retained for further consideration. Microencapsulation has been used primarily in the nuclear industry to encapsulate radioactive sludges and is considered feasible at the Ash Landfill.

Physical separation technologies include soil washing and magnetic classification. Soil washing is considered to be effective and feasible remedial technology for this site and has been retained for

incorporation as a remedial alternative. Magnetic classification of soils would not be effective at this site since most of the constituents of concern are non-magnetic.

Soil washing is a water-based process for mechanically extracting soils to remove organic and inorganic pollutants. The wash solution is then treated to remove the pollutants from solution after which it is recycled back to the soil washing process. It has applicability for a wide variety of soil types and conditions but is more effective for heterogeneous soils that are composed of a large fraction of coarse particles and a smaller fraction of fine particles. The chemical contaminants of concern, such as semi-volatiles, tend to sorb to the fines or become entrained with the fines of the soil matrix, i.e. particles that are less than 0.25 mm. Since the fines are comprised of a large surface area and contain iron and manganese oxides, which are effective natural sorbents, the pollutants are strongly held during the washing process. Although the process does not effectively remove these pollutants from soil by dissolution, washing can be the first step in an effective treatment train since the washing process reduces the volume of soil that may require further treatment or disposal. Volume reduction by particle size separation is important because pollutants, once separated by washing, can be treated using various treatment schemes including a soil slurry bioreactor, acid extraction or solidification. Washing processes that separate the smaller fraction of fine clay and silt particles from the larger fraction of coarse sand and gravel soil particles can effectively separate and concentrate chemical constituents into a smaller volume of soil that can be further treated or disposed. The clean, larger fraction of coarse material can be returned to the site for continued use. Therefore, by employing a combination of physical separation techniques, the process of soil washing will decontaminate the large diameter fraction of soil and reduce the volume of waste material by causing constituents to be separated from the larger quantity of coarse particles and concentrate these materials into the smaller quantity of fine particles.

A number of unit processes are incorporated in any soil washing treatment train. Many of the processes used in soil washing utilize equipment and techniques that are typically used in the mining industry for material sizing operations. These sizing and washing processes are water intensive and therefore, water availability is an essential requirement. Variations in vendor soil washing schemes, equipment and washing solutions occur depending on the site conditions, and the cleanup goals. Many vendor processes include proprietary aspects that limit detailed descriptions of the process. In general, soil is first excavated and sized to remove oversized objects. The oversized objects are then washed in a separate process that may involve a high pressure spray washer. The remaining soil is slurried with clean make-up water and recycled process treatment

water in a mixing trommel where coarse particles are removed. The soil slurry remaining is fed to a floatation unit where hydrophobic constituents are removed as a froth. The underflow can be mixed with washwater and extraction agents, such as detergents/surfactants, to remove contaminants by dissolution or suspension. Using a series of soil classification process equipment such as attrition machines, hydrocyclones, rotary screens and spiral classifiers, the remaining slurry is separated into a washed product and a fine fraction consisting of silts and clays. The silt and clay fraction that may still contain unwashed pollutants can then treated using biological techniques, solidification or be disposed of in an appropriate landfill.

Soil washing consists of many of the technologies listed on Table 2-8 including:

Physical-Separation

dry screening (grizzly)
dry screening (vibratory screen)
wet trommel screens
wet sieves
attrition scrubber (wet)
dense media separator (wet)
hydrocyclone separators
flotation separator
gravity separators
dewatering

Chemical-Extraction

washwater treatment/recycle
residual treatment and disposal
treated water discharge

The coarse fraction may typically be backfilled or otherwise reused as daily landfill cover while the fine fraction may be subsequently treated via technologies such as slurry bioreactors, acid extraction or solidification.

The throughput of a soil washing system can vary depending upon the vendor. Common throughput rates are between 15 to 20 tons/hr.

Thermal oxidation technologies are feasible, providing a vendor can be found to accept this material at an off-site location and have been retained for future consideration as part of a remedial alternative.

Other oxidation processes, such as supercritical, chemical, and microwave plasma processes, were not considered feasible or effective for use at this site since these technologies are not proven and have been screened from future consideration.

Chemical extraction of soils are effective for extracting organics or oily waste materials but are not effective for removing inorganic constituents. Since the RAO for this project involves inorganics, and the soil and sediments at the Ash Landfill are not impacted with oily waste, this technology was not considered effective and was screened out.

2.5.2.7 Disposal

The following process operations have been considered for the disposal technologies:

- Backfilling of clean soil,
- RCRA hazardous waste landfill and
- Solid waste landfill.

Solids Handling: Backfill On-site

Soil that has been treated by a source control technology may be backfilled into the excavation area provided remedial goals are met.

Solids Handling: Subtitle D Landfill

The Subtitle D landfill refers to a solid waste landfill, either constructed on-site at SEDA, or an existing municipal landfill 10 to 40 miles from SEDA. Such a landfill would meet NYSDEC and EPA RCRA Subtitle D landfill construction specifications. The on-site landfill would be constructed near the Ash Landfill, at the NCFL.

2.5.3 Screening of Technologies for Groundwater Migration Control and Treatment

Remedial action technologies and processes are screened on Table 2-11, based on whether a process is technically feasible and effective for remediating soils/sediment and whether it meets the

remedial action objectives. As shown on Table 2-11, processes that are shaded have been screened out based on screening comments listed.

The following technologies and processes were retained for further evaluation as groundwater remedial alternatives:

- Access controls: fencing and security, wall and posting, deed restrictions
- Vertical barriers: slurry wall, sheet pile
- Monitoring: groundwater monitoring
- Alternative water supply: city water line or bottled water
- Vertical collectors: interceptor trench
- Biological: air sparging
- Biological: Two stage anaerobic/aerobic reactor
- Physical/Chemical: air stripping
- Physical/Chemical: UV oxidation
- Physical/Chemical: hardness removal/precipitation
- Physical/Chemical: filtration
- Physical/Chemical: carbon adsorption - liquid phase
- Physical/Chemical: carbon adsorption - vapor phase

2.5.3.1 No Action

The No Action would meet the requirements of the RAOs for protectiveness of groundwater or human health over time. This response provides the baseline against which other responses can be compared.

2.5.3.2 Institutional Control Technologies

Institutional control technologies that have been considered includes:

- Access Controls, such as fencing, wall and posting, and deed restriction;
- Monitoring of groundwater; or
- Alternative water supply.

Institutional control technologies are only applicable to the receptor and do not involve reductions in the volume, toxicity or control of wastes at the site. Physical barriers that restrict access to the site are feasible and effective in preventing humans from becoming exposed to on-site impacts. There are a number of institutional controls that are currently in-place at the Ash Landfill, and that may be a part of any long-term solution. Access to the site is limited by a fence that surrounds the entire Depot and by 24-hour security patrols. Permanent walls with sign posting could also be used around the impacted area.

Another type of institutional control is a deed restriction. This is more applicable as a source control measure, but could be used to indicate that no drinking water wells should be constructed at the site.

Monitoring: Groundwater Monitoring

Groundwater monitoring is another institutional control. Quarterly monitoring is already in place for over 30 wells at the site. The monitoring program can be modified to account for the results of the remedial activities.

Alternative Water Supply: City Water or Bottled Water

An alternative water supply could be provided for any future residences at the site and off-site that would normally rely on groundwater. The nearest residence, located on Smith Farm Road, has three wells that use both the overburden and the bedrock aquifer. Quarterly monitoring of these 3 wells for volatile organics has been performed since 1987 and has not detected any of the contaminants from the site.

2.5.3.3 Containment Technologies

Three types of caps were considered in this evaluation. These include caps comprised of :

- Soil,
- Clay and,
- Asphalt.

A soil cap would involve covering the previously affected areas of the Ash Landfill site with up to a foot of clean fill in order to promote a grass cover. The cap would control the exposure from

inhalation of soil dust, prevent runoff of impacted particles and prevent exposure of to humans and ecological receptors due to ingestion of metals in soil but would not be effective in meeting the RAO of protecting groundwater.

The third option for capping is an asphalt cap which involves constructing a cap of highway-grade base and asphalt pavement over the entire site. However, the asphalt cap is considered less reliable than the clay or soil cap and requires more maintenance. This option was ????? out due to high costs.

Vertical barriers involve preventing interaction between groundwater and buried wastes by surrounding the waste materials with an impermeable vertical wall. Four process operations for vertical walls were considered and include:

- Steel Sheet Pilings,
- Slurry Walls
- Grout Curtains, and
- Vibrating Beam.

Of the four vertical technologies considered, only slurry walls and sheet pilings were retained for combination as a remedial alternative since these technologies were considered that most effective for preventing groundwater flow. Slurry walls are the most reliable and have numerous applications in the field of hazardous waste remediation.

Vertical Barriers: Slurry Wall, Sheet Pile

A slurry wall is a subsurface barrier used to divert or contain a groundwater plume. A slurry wall is constructed by digging a trench down to an impermeable zone, which at the Ash Landfill would be the competent shale. The trench is then filled in with bentonite, or some other impermeable material. Slurry walls generally require low maintenance, and are a proven technology in similar applications, providing the bottom of the slurry wall is "keyed" into an impermeable material. Slurry walls can be used to divert incoming clean water from a contaminated area or can be installed completely around the contaminated area, thereby isolating the area. If the area is totally isolated then either a cap must be installed or water must be removed, treated and discharged out of the isolated area. If water is not removed from the isolated area then infiltrating rainfall may cause mounding of groundwater within the slurry wall, leading to breakout at the surface.

2.5.3.4 Diversion Technologies

Five process operations were considered for vertical barriersand include:

- Slurry Walls,
- Grout Curtains,
- Vibrating beams, and
- Interceptor Trench.
- Sheet piling

However, the use of slurry walls, grout curtains, and vibrating beams for diversion are not as effective as for containment. Therefore, these process options have been screened out. The interceptor trench is more effective as a collection system than as a diversion system, and therefore the interceptor trench has been eliminated as a diversion technology.

2.5.3.5 Collection Systems

The use of the interceptor trench for the collection of contaminated groundwater is very effective for the Ash Landfill site which has a shallow aquifer.

An interceptor trench is a 2- to 3-foot wide trench dug to the top of the impermeable competent shale bedrock. The trench is lined with a geotextile that helps minimize the collection of fine soil particles that could clog the drainage system. A perforated PVC pipe may be placed in the trench, and sloped to a low point collection sump. A number of sumps may be used depending on the natural slope and the length of the trench. The trench is then filled with gravel or some other highly permeable material. The top 1 to 2 feet of the trench can be backfilled with the removed soil in order to minimize inflow of rainwater. Interceptor trenches can be used to cut off the forward migration of a plume, by the use of vertical barriers such as sheet piling or can be used in the middle of a plume as a collection device.

Collector wells are not a cost-effective technology and have been screened out. Because of the glacial till overburden, numerous wells would be required to be effective.

2.5.3.6 In-Situ Treatment Technologies

The following in-situ treatment technologies were considered as potential remedial alternatives :

- Biological Extraction Technologies
    - Aerobic
    - Anaerobic, and
    - Air Sparging

Subsurface conditions at the Ash Landfill are unfavorable for the aerobic and anaerobic treatment systems.

Biological: Air Sparging

Air sparging is a technique that uses a large number of wells to inject air and nutrients into the groundwater plume. The treatment uses a combination of air stripping and in-situ biological treatment. The system may be operated aerobically or anaerobically, depending on the nature of the contaminants. In an aerobic system, air or oxygen is injected. In an anaerobic system, methane is typically injected.

2.5.3.7 On Site Treatment Technologies

The following technology types and process options were determined to be applicable based on the screening criteria:

- Biological Technologies
    - Aerobic
    - Anaerobic
    - Landfarming
    - Anaerobic/aerobic reactor

- Physical/Chemical Separation Technologies
    - Reverse Osmosis
    - Ultraviolet Oxidation
    - Reduction
    - Neutralization
    - Hydrolysis
    - Wet Air Oxidation
    - Supercritical Water Oxidation

- Ion Exchange
- Air Stripping
- Steam Stripping
- Distillation
- Precipitation/coagulaton/flocculation
- Sedimentation/clarification/gravity thickening
- Hardness Removal
- Filtration
- Carbon Adsorption - liquid phase
- Carbon Adsorption - vapor phase
- Mechanical aeration

The three ex-situ biological treatment processes, aerobic biodegradation, anaerobic biodegradation, and landfarming, have been screened out since they are effective for soils that have been impacted with organic constituents and would not meet the objectives for reducing the concentration of the metals in soil.

Biological: Two Stage Anaerobic/Aerobic Reactor

A two stage anaerobic/aerobic reactor is a two step on-site treatment process. In the first step, chlorinated organics are dechlorinated biologically under anaerobic conditions. This is followed by aerobic oxidation using either a fluidized bed reactor or a solid-phase fixed-film reactor.

Of the 18 physical/chemical technologies, 7 technologies were retained. These are described below.

Physical/Chemical: Air Stripping

Air stripping is another common groundwater treatment process which is very effective in treating TCE and 1,2-DCE. The groundwater is passed through the stripping tower, where it is contacted by a countercurrent air stream. Trays or column packing is used to increase the surface area of the air/water contact. The organic constituents are transferred from the water to the air. Next, depending on the air emissions requirements, the air phase may be treated, or directly discharged. Vapor-phase activated carbon may be used to treat the air stream. The air passes through the carbon which, as described above, adsorbs the organic constituents. The spent carbon is then sent off site for regeneration or disposal.

Physical/Chemical: UV Oxidation

UV Oxidation is a treatment technique that combines ultraviolet (UV) light with an oxidizing agent (peroxide and/or ozone) to destroy organic constituents. It is especially effective for chlorinated organics, such as TCE and 1,2-DCE. The water is mixed with peroxide, and then enters the UV reaction chamber. Ozone is added to the reaction chamber, and OH radicals are formed. The formation of the OH radicals is catalyzed by the UV light. The OH radicals react rapidly with the chlorinated organics, generating CO_2 and water. Any ozone not reacted is decomposed in an off-gas treatment unit prior to discharge.

Physical/Chemical: Hardness Removal/Precipitation

In general, all of the organic treatment processes considered for the groundwater at the Ash Landfill are subject to scaling, fouling, or plugging if the groundwater is high in hardness, alkalinity, iron, or other minerals. The groundwater at the Ash Landfill is fairly high in hardness and alkalinity, and some pretreatment of the water would be necessary to optimize the performance of an organic treatment unit.

Physical/Chemical: Filtration

Filtration is another important unit operation. Filtration will remove silt and precipitated metals prior to the organic treatment unit. This will help the efficiency of the organic treatment unit and provide for a better discharge. A variety of filters have been used in groundwater remediations, including inline pressure filters, sand-bed filters, and multi-media bed filters. The specific filter used will depend upon the specifications of the organic treatment unit, and cost and maintenance considerations.

Physical/Chemical: Carbon Absorption-Liquid Phase

Activated carbon is another common treatment technique used for groundwater remediation and has been shown to be very effective in treating TCE and 1,2-DCE. The groundwater after pretreatment is passed through carbon beds. The organic contaminants are adsorbed in the carbon and removed from the water. Over time, the adsorptive capacity of the carbon is diminished and the effluent concentrations will start to increase. At this point new carbon beds are installed and the spent carbon is sent offsite for regeneration or disposal.

Physical/Chemical: Carbon Adsorption-Vapor Phase

Vapor-phase carbon may be used in conjunction with a number of the other migration control technologies. The purpose of vapor-phase carbon is to treat the off-gas to minimize air emissions. Vapor-phase carbon is very efficient in capturing TCE and heavier organics. It is somewhat less efficient at capturing DCE, and lighter organics. Carbon is extremely inefficient in capturing vinyl chloride.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 INTRODUCTION

This section summarizes various remedial technologies that were combined to form remedial alternatives. Prior to the development of alternatives, this feasibility study performed an evaluation of general response actions and technology screening for inclusion into proposed remedies, applicable to the Ash Landfill site. General response actions are broad response categories based on the findings of field work conducted. Technologies have been combined into alternatives considering the waste-limiting (waste characteristics that limit the effectiveness or feasibility of a technology) and site-limiting (site characteristics such as a high water table that preclude the use of a technology) factors unique to the site, and the level of technical development for each technology. The rationale is presented for how and why the selected technologies were assembled into remedial action alternatives. The quantitative data were used to differentiate alternatives with respect to the three screening criteria: effectiveness, implementability and cost.

Assembling and screening of alternatives have been conducted separately in terms of Source Control for soil/sediment and Migration Control for the groundwater plume. For the Ash Landfill, four source control alternatives (designated as SC-1 through SC-4) and seven migration control alternatives (designated as MC-1 through MC-7) will be developed and evaluated. The separation of the remedial alternatives into Source Control and Migration Control alternatives is based on several factors.

As discussed in previous sections, Remedial Action Objectives and site-specific cleanup goals were developed for the two media of concern, groundwater and soil. The Remedial Action Objectives for soil focus on mitigating exposure pathways for dermal contact and ingestion of metals and PAHs. The Remedial Action Objectives for groundwater involve management of the VOC plume which includes improving the quality of the existing plume and managing the migration of the plume off-site. Because of the different constituents of concern in the soil (metals and PAHs) and groundwater(trichloroethene, dichloroethene, and vinylchloride), the technologies which will be required for the remedial action alternatives will be different for each media. That is, the technologies and actions for Source Control and Migration Control are clear and distinct for each media. Completion of the Removal Action for the source of the groundwater plume has minimized the interaction between the soil and the groundwater media. According to Section 4.2.6 of the CERCLA RI/FS Guidance Manual

(USEPA, 1988), if interactions between the two media are not significant, an FS may describe options by media instead of on a site-wide basis. This approach permits greater flexibility in developing alternatives. Separation of Source Control alternatives and Migration Control alternatives provides a more effective means of implementing a remedial action as evidenced by the non-time critical removal action. Remedial Action Objectives for each media may be achieved more effectively by developing and conducting the alternatives independently of one another.

3.2 ASSEMBLY OF ALTERNATIVES

This section presents the rationale for assembling technologies and processes that remain following the technology screening, summarized in Section 2.0, into remedial action alternatives.

For source control, the following general response actions were retained:

- No-action
- On-site consolidation and containment,
- On-site treatment including innovative technologies, and
- Off-site disposal.

Technologies and processes associated with these actions are assembled into alternatives and presented in Table 3-1.

Alternative SC-1 is the No-Action alternative. The No-Action alternative is the alternative that provides the baseline against which other responses can be compared. The no-action response will result in leaving on-site soil source areas intact and continuation of existing site security measures, to preclude civilian access and direct contact with soil. The intended future use of this site is as a meadow grassland and is not intended to include human activities other than an occasional hunter.

The no-action response may be appropriate for source areas where natural environmental mechanisms will result in degradation or immobilization of constituents or where the risk is within acceptable target ranges. Because the non-time critical removal action has been completed, a no-action response to source control at the Ash Landfill site does not allow for

Table 3-1

Assembled Remedial Source Control Alternatives

Alternative	Technologies and Processes
SC-1	No Action.
SC-2	Excavation of both landfills/Disposal in an off-site non-hazardous Subtitle D landfill.
SC-3	Excavation of various areas of the Ash Landfill/Consolidation to the Non-Combustible Fill Landfill (NCFL)/Cap the NCFL.
SC-4	Excavation/Wash/Backfill coarse fraction/Landfill and solidity fine fraction.
SC-5	Excavation of Debris Piles/Off-site Subtitle D Landfill/NCFL and Ash Landfill Areas Cover.

the continued release of volatile organic contaminants into the overburden aquifer system. However, the no-action response also could allow for the off-site migration of contamination through groundwater. Therefore, the choice of source control responses directly affects the management of migration response.

The rationale for choosing SC-1 (the no-action alternative) is that Guidance requires that it be chosen.

Alternatives SC-2 through SC-5 are remedial alternatives that may be utilized for reduction of potential health risks associated with heavy metals and PAHs. A description of the alternatives and the rationale for choosing these alternatives is given below.

SC-2 involves excavation of either all or portions of the Ash Landfill, the debris piles, the Non-Combustible Fill Landfill (NCFL) and disposal in an off-site Subtitle D landfill. The rationale for this excavation alternative is that it is effective, implementable and would be relatively cost effective for managing the constituents of concern (i.e.,metals and PAHs) that remain following the elimination of the VOCs. Excavation, hauling, and disposal involves a combination of technologies that are readily available and proven. Together these technologies provided an alternative that would reduce levels of metals and VOCs in soils below NYSDEC TAGMs and eliminate potential pathways of exposure for on-site and off-site receptors.

SC-3 is consolidation of the debris piles and the Ash Landfill area to the NCFL where the wastes will be capped in place. The rationale for combining these technologies is somewhat similar to that for SC-2 above. The exception being that by consolidating the areas of the Ash Landfill to the NCFL, a less conservative alternative is chosen; it is less conservative because the constituents of concern remain on-site. Because the constituents of concern remain on-site in the NCFL, capping is a necessary technology that will require future maintenance and monitoring in order to ensure the stability of the landfill and prevent runoff or erosion of the landfill contents or leaching of the constituents.

SC-4 involves excavation of contaminated soil material from the Ash Landfill, debris piles and the NCFL, washing the material to separate the coarse fraction of the soil from the fine fraction and solidifying of the fine fraction. The coarse soils that exceed the Toxicity Characteristic Leaching Procedure (TCLP) requirements will be solidified prior to landfilling in the NCFL. Experience at other sites employing soil washing indicates that the separated

fine portion of the soil will contain a large portion of the contaminants of concern. Coarse soils that do not exceed TCLP requirements will be backfilled on-site. For many of the alternatives considered, treatability testing will be an integral part of a final full-scale design and construction. The rationale for combining excavation, soil washing, solidification and landfilling of soil is that these technologies provide an effective means of reducing the volume of the soils impacted by the constituents of concern. Reducing the overall soil volume requiring treatment means that the cap will be smaller and therefore will require less long term maintenance and monitoring. Further, since the soil washing effort will produce a fraction, comprised of fines, solidification will be easier to implement as the solidification technology involves mixing in order to achieve a uniform matrix. Larger materials do not mix as well nor do larger particles form as effective a bond than the smaller fractions do. The combination of technologies provides a more permanent solution than excavation and landfilling on-site and (Alternatives SC-3) as a smaller solidified monolithic mass would be less susceptible to erosion leaching to groundwater.

SC-5 is the excavation of the Debris Piles and disposal in an off-site Subtitle D Landfill. The Ash Landfill and the NCFL would be covered with a 9" soil cover and revegetated. The rationale for this alternative is that the Debris Piles contain the highest levels of lead and the removal of these source areas would reduce the site risks and comply with ARARs cost effectively.

The general response actions retained for groundwater migration control are:

- No-action
- Institutional controls
- Collection
- In situ treatment
- On-site treatment

Technologies and processes associated with these actions are assembled into alternatives and presented in Table 3-2.

Alternative MC-1 is the no-action alternative. This general response action is the baseline for comparison to other alternatives. The rational for choosing this alternative is that EPA Guidance requires it to be one of the alternatives chosen.

Table 3-2

Assembled Remedial Alternatives for Migration Control

Alternative	Technologies and Processes
MC-1	No Action.
MC-2	Natural attenuation and degradation of plume/ institutional controls
MC-3/MC-3a	Air sparging of plume/Funnel-and-Gate System/Iron Filings
MC-4	Interceptor trenches/tank storage/filtration/liquid-phase activated carbon/Discharge to surface water
MC-5	Interceptor trenches/tank storage/filtration/air stripping/Discharge to surface water
MC-6	Interceptor trenches/tank storage/filtration/UV Oxidation/Discharge to surface water
MC-7	Interceptor trenches/tank storage/filtration/two-stage biological treatment/Discharge to surface water

Alternative MC-2 uses natural attenuation for reduction of contaminant levels in the plume in combination with institutional controls such as land use restrictions, groundwater monitoring, and alternative water supply. The rationale for combining institutional controls with long term monitoring as an alternative is that, if the exposure to contaminants of concern is eliminated, there can be no risk since there is no dose. Although NYSDEC groundwater standards are exceeded in on-site wells, the concentrations are being reduced by natural processes and will reach an allowable level in the future. To protect off-site receptors, monitoring wells will be installed along the SEDA boundary. If the groundwater data from these monitoring wells indicate a statistically significant rising trend in the concentrations of VOCs, a contingency plan would be initiated. The contingency plan would include implementing a deed restriction and/or supplying an alternative water supply for off-site residences which may be impacted. Combined with a long term monitoring strategy, this alternative is effective at protecting human health. This alternative does not require any additional technologies to meet the remedial action objectives for the Ash Landfill site and therefore is readily implementable since it involves only monitoring and other institutional controls. Additionally, this alternative provides a low cost alternative to meeting these objectives.

Alternative MC-3 uses an in situ treatment process (air sparging, or iron filings) to achieve reduction in groundwater VOC concentrations. It was determined that an in-situ alternative should be considered and combining an and cut-off wall and air sparging or iron fillings treatment of the plume for VOCs provides an effective in situ remedial alternative. The trench and/or cutoff wall allows for the collection of a significant volume of water through which air could be injected, thus assuring efficient sparging of the groundwater. The trench and cut-off wall also provides a physical mechanism to ensure that all the groundwater will be treated. Because of the low permeability of the soils, standard sparging of groundwater through air injection wells would not be as effective a treatment alternative as the trench and/or cut-off wall. Even if artificial fracturing of the soils was performed, the true effectiveness and extent of the fracturing, and the sparging, would not be assured.

Alternatives MC-4 through MC-7 are variations of the "pump-and-treat" scenario. In these alternatives, the groundwater is collected and treated on-site, and then is discharged to a surface water body such as the drainage ditches along the patrol roads. These alternatives consider various treatment technologies.

The rationale for MC-4 is that activated carbon is an effective mechanism in reducing the concentration of dissolved organics in water. This alternative was developed because of its reliability, effectiveness and implementability.

MC-5 is a variation of MC-4 that considers air stripping rather than activated carbon. This alternative was considered because it is well documented to be reliable, is effective for dissolved VOCs in water, and is implementable.

MC-6 utilizes ultraviolet oxidation as a treatment process and is effective for dissolved organics in water. It is also well documented to be an efficient means for completely destroying, through chemical reactions, the constituents of concern. MC-4 and MC-5 do not destroy the organic constituents of concern but transfer them to another phase. There is no air or waste emission from ultraviolet oxidation and it is an alternative that is well documented as an on-site destruction alternative and should be considered.

The MC-7 alternative was developed as an innovative technology for migration control that provides on-site destruction and was deemed appropriate. The two-stage biological reactor is a new technology that has shown promise in the limited number of applications it has been used.

3.3 DESCRIPTION OF ALTERNATIVES FOR SOURCE CONTROL

3.3.1 General

Remedial response actions, technologies, and processes, were evaluated without incorporating the specific site remedial requirements of the Ash Landfill. This approach was required to evaluate the large number of possible remedial actions. In order to narrow the alternatives analyzed in detail in Section 5.0, these general response actions will be evaluated considering site specific factors.

The technologies and processes that make up the source control alternatives are defined in sufficiently greater detail to allow for screening of the alternatives. These technologies include:

- capping,
- excavation/hauling,

- solidification/stabilization,
- soil/sediment washing,
- RCRA subtitle D landfill,

In addition to better defining technologies and processes, the quantity of material to be remediated is also considered. Order of magnitude unit costs were developed based on technology definitions and material quantities. These costs were then utilized as one of the alternatives screening criteria. The final decision regarding specific remedial technologies and processes may be dependent on the results of treatability studies proposed in Section 4.

3.3.2 SC-1, The No-Action Alternative

The No-Action Alternative was evaluated as a comparison for all other alternatives to address the soils that exist at the site. The contribution of risks, both carcinogenic and non-carcinogenic, resulting from the presence of site soils were evaluated during the baseline risk assessment of the RI. Consequently, the No-Action Alternative has been evaluated based upon the results of this analysis of risk. The decision to implement the No-Action Alternative is a function of the exposure scenarios considered during the analysis of risk which is closely tied to the current and intended future land use of this site. This parcel is currently under control of the U.S. government, i.e., the U.S. Army, which regulates the current and future land uses. The U.S. Army has no intention to utilize this land for any purpose other than it is currently being utilized for, which is as a grassland/meadow. Therefore, under this land use scenario the most reasonable exposure scenario would include an occasional site visitor such as a hunter, an occasional site worker and the existing off-site residences.

If the future intended use of this parcel changes, then in accordance with Army Regulation AR-200.1, the unacceptable risks that result from this future use will need to be addressed. At that time, full disclosure of the intended land use and the consequences occurring from these uses will be made to the appropriate regulatory authorities. Under the current exposure scenarios, the site risks totalled 1.0×10^{-4} for carcinogenic and the non-carcinogenic risks, and the total Hazard Index (HI) was 0.24. The EPA target range for carcinogenic risks are 1×10^{-4} to 1×10^{-6} and the EPA target for non-carcinogenic risk is an HI less than one. Since the current and intended use site risks border the EPA target range for carcinogenic risks and are less than the required non-carcinogenic target, the risks from the site soils are acceptable. From the standpoint of risk, considering that the non-time critical removal action has removed the source of VOCs in soils at the Ash Landfill, there is no requirement to do

any soil remedial action. Since neither the EPA or NYSDEC have promulgated soil quality standards, the current site conditions do not violate any ARAR. However, soils with lead concentrations above the established clean-up goal of 500 mg/kg for the protection of groundwater remain on site.

3.3.3 SC-2 Excavation of Both Landfills/Disposal in an Off-site Subtitle D Landfill

This alternative involves excavation of either all or portions of the Ash Landfill, the refuse burning pits, the Non-Combustible Fill Landfill (NCFL), and the residuals that remain in the "Bend-in-the-Road" area. This alternative is considered feasible for control of residual materials such as ash and debris that contain non-hazardous concentrations of metals and non-volatile organics, such as PAH compounds, PCBs, pesticides, phthalates and other semi-volatile organic compounds. These constituents may exhibit a human health risk under very limited conditions, even though the removal action has been completed. SC-2, is directly applicable since the remediation of the soils impacted with volatile chlorinated organic compounds at the "Bend-in-the-Road" have been remediated. If the removal action had not been completed, alternative SC-2 would not be appropriate for the soils at the "Bend-in-the-Road" because, based upon groundwater data, the soils at the "Bend-in-the-Road" would likely have exceeded the Toxicity Characteristics Leaching Procedure (TCLP) limits. Thus they would have been considered a characteristic hazardous waste if they had been excavated; the characteristic that would have exceeded the TCLP limit in this case would have been trichloroethane (TCE). Subtitle D landfills are not regulated hazardous waste landfills, therefore, excavated soils that exhibit the characteristic of a hazardous waste could not be disposed of in this manner. In accordance with the RCRA Land Disposal Restrictions (LDRs), soils considered to be hazardous waste cannot be land disposed of until the "characteristic" that causes these soils to be considered hazardous is eliminated. At the Ash Landfill, this "characteristic" (TCE) has been remediated to meet the clean-up goals of the removal action.

Both of the landfills at the site, the NCFL and the Ash Landfill, were constructed prior to the implementation of solid waste regulations that specify the construction and operation of non-hazardous waste landfills. Accordingly, this alternative is intended to consider the feasibility of excavating this operable unit, i.e., the several Solid Waste Management Units (SWMUs) that have been combined as the Ash Landfill operable unit, and disposing of this material, off-site, in a Subtitle D non-hazardous waste landfill. The results of the RI indicate that this unit and the associated SWMUs are well defined localized areas that are shallow,

i.e. less than 10 feet deep, and could be removed with standard construction equipment. The removal and management of the residual non-volatile constituents in an off-site, licensed, non-hazardous waste municipal landfill provides a proven relatively cost-effective alternative for management of on-site residuals. An existing Subtitle D municipal landfill is located approximately 40 miles from SEDA and would be able to accept non-hazardous solid waste.

3.3.4 SC-3, Excavation of Various Areas of the Ash Landfill/Consolidation to the Non-Combustible Fill Landfill (NCFL)/Cap the NCFL

As with SC-2, this alternative is feasible for the non-volatile residuals at the site. This alternative would be feasible for management of areas not impacted with volatile organics or for the non-volatile residuals that exist in the two areas where volatile organics were removed from the soils for the removal action. On-site landfilling and capping of the volatile organic contaminated soils at the "Bend-in-the-Road" area would not have been feasible due to the likely exceedance of the TCLP limit for TCE. If VOCs had not been removed for the removal action, these soils, if excavated, would likely have been considered a "characteristic" hazardous waste due to their toxicity. Although, TCLP testing was not performed during the RI, the concentrations of TCE in these soils were sufficiently high (i.e. a maximum of 540mg/kg) to suggest that a portion of these soils would have exceeded the TCLP limits and therefore would have been restricted from land disposal. The removal action has met the clean-up goals for TCE in these soils.

There are also areas at the site, such as the debris piles, the refuse burning pits, and the Ash Landfill, that contain elevated concentrations of heavy metals, pesticides and PAHs. Although leaching and migration into groundwater is not currently occurring, erosion and overland transport could be a potential transport mechanism.

3.3.5 SC-4, Excavation/Soil Washing/Backfill Coarse Soil Fraction/Landfill and Solidify Fine Fraction on Site

Current soil washing technologies were reviewed in order to obtain accurate information regarding what techniques are being utilized for the decontamination of soils containing heavy metals and organics.

All of these technologies are based to some extent on mineral processing technology. Soil washing can involve both physical or chemical treatment. Most soil washing technologies use some form of chemical treatment in addition to physical processing. Chemical treatment

attempts to solubilize the contaminant and leach the adsorbed pollutant from the soil. Physical treatment attempts to concentrate and separate the contaminated soil components from the remainder of the soil.

Chemical treatment leaches contaminants from the soil particles, placing them in an aqueous phase. Once the contaminants have been solubilized, the liquid is separated from the solid resulting in clean soil particles. Choice of reagent for chemical treatment is dependent upon the type of contaminant, the degree of contamination and the chemical and physical characteristics of the soil.

The physical methods of soil washing have been derived directly from mineral processing technology. Physical treatment/mineral processing separates particles from one another; no chemical bonds are broken and no phases are changed. The effectiveness of mineral processing technology is dependent on the physical property variations of the influent particles. No separation is obtained if particles have similar physical characteristics. Physical treatment of contaminated soil is based on the hypothesis that the majority of contamination resides with the fine soil particles. Therefore, by separating the coarser soil from the fine soil fraction, the overall volume of contaminated soil is reduced.

Current soil washing processes employ similar unit operation and treatment approaches, which have been synthesized into vendor specific general process flow diagrams. Particle size separation is utilized in the majority of technologies; treatment of the fine particles is accomplished as a separate unit operation.

This treatment technology has potential application at this site since the soil matrix contains a high percentage of fines ranging from 30 to 70 percent which will contain the majority of non-volatile constituents. Volume reduction will result in lower eventual disposal or treatment costs (i.e. solidification) and smaller space requirements for on-site disposal. The treatment process scheme would involve processing the fraction of the site soils that contain the heavy metals and/or the PAH constituents. The soil washing process would be used to concentrate these non-volatile components into the fine fraction which would then be amenable to solidification using either a pozzolanic or siliceous matrix. This matrix would prevent leaching of these residual materials through both chemical and physical barriers that would exist in the solidified monolithic mass. This mass would then be landfilled on the site in the location from where the excavation was originally performed and capped to further mitigate long term exposure.

Soil washing is a water-based process for mechanically extracting soils to remove organic and inorganic pollutants. The wash solution is then treated to remove the pollutants from solution after which it is recycled back to the soil washing process. It has applicability for a wide variety of soil types and conditions but is more effective for heterogeneous soils that are composed of a large fraction of coarse particles and a smaller fraction of fine particles. The chemical contaminants of concern, such as semi-volatiles, tend to sorb to the fines or become entrained with the fines of the soil matrix, i.e.,particles that are less than 0.25 mm. Since the fines are comprised of a large surface area and contain iron and manganese oxides, which are effective natural sorbents, the pollutants are strongly held during the washing process. Although the process does not effectively remove these pollutants from soil by dissolution, washing can be the first step in an effective treatment train since the washing process reduces the volume of soil that may require further treatment or disposal. Volume reduction by particle size separation is important because pollutants, once separated by washing, can be treated using various treatment schemes including a soil slurry bioreactor, acid extraction or solidification. Washing processes that separate the smaller fraction of fine clay and silt particles from the larger fraction of coarse sand and gravel soil particles can effectively separate and concentrate contaminants into a smaller volume of soil that can be further treated or disposed. The clean, larger fraction of coarse material can be returned to the site for continued use. By employing a combination of physical separation techniques, the process of soil washing will decontaminate the coarse fraction of soil and reduce the volume of waste material requiring treatment.

A number of unit processes are incorporated in soil washing. Many of the processes utilize equipment and techniques used in the mining industry for material sizing operations. These sizing and washing processes are water intensive and as a result, water availability is an essential requirement. Variations in vendor soil washing schemes, equipment and washing solutions are common depending on the site conditions and the cleanup goals. Many vendor processes include proprietary aspects that limit detailed descriptions of the process. In general, soil is first excavated and sized to remove oversized objects. The oversized objects are then washed in a separate process that may involve a high pressure spray washer. The remaining soil is slurried with clean make-up water and recycled process treatment water in a mixing trommel where coarse particles are removed. The soil slurry remaining is fed to a floatation unit where hydrophobic constituents are removed as a froth. The underflow can be mixed with washwater and extraction agents, such as detergents/surfactants, to remove contaminants by dissolution or suspension. Using a series of soil classification process equipment such as attrition machines, hydrocyclones, rotary screens and spiral classifiers, the

remaining slurry is separated into a washed product and a fine fraction consisting of silts and clays. The silt and clay fraction that may still contain unwashed pollutants can then treated using biological techniques, solidification or be disposed of in an appropriate landfill.

Soil washing consists of many of the technologies listed on Table 2-10 including:

<u>Physical-Separation</u>

- dry screening (grizzly)
- dry screening (vibratory screen)
- wet trommel screens
- wet sieves
- attrition scrubber (wet)
- dense media separator (wet)
- hydrocyclone separators
- flotation separator
- gravity separators
- dewatering

<u>Chemical-Extraction</u>

- washwater treatment/recycle
- residual treatment and disposal
- treated water discharge

The coarse fraction may be backfilled on-site or otherwise reused as daily landfill cover while the fine fraction may be subsequently treated via technologies such as slurry bioreactors, acid extraction or solidification.

The throughput rate of a soil washing system can vary depending upon the vendor. Common throughput rates are between 15 to 20 tons/hr.

Acid extraction treatment is a soil washing process that could be used following separation to extract heavy metals from the fines. A combination of flurosilcic acid, nitric acid, and hydrochloric acid have been utilized as effective agents for solubilizing metal contaminants in various soil washing processes. In general , acid is then slowly added to a water and soil slurry to achieve and maintain a pH of 2. Precautions are taken to avoid lowering the pH below 2 and disrupting the soil matrix. When extraction is complete, the soil is rinsed, neutralized, and dewatered. The extraction solution and rinsewater are regenerated. The regeneration process removes entrained soil, organics, and heavy metals from the extraction fluid. Heavy metals are concentrated in a form potentially suitable for recovery. Recovered acid is recycled to the extraction unit. Although feasible this process is unlikely for this site since the concentration of the metals is not sufficiently high to warrant this aggressive process.

The added cost and safety issues associated with using acid is also unattractive. The efficiency of removing the organic contaminants with acid is also of concern and it is likely that many organic contaminants would remain with the acid extracted soil. For these reasons, acid extraction will not be considered further.

Following the soil washing process, the separated fines can also be biologically treated using a slurry reactor. Soil is slurried in large tanks where air is simultaneously injected to support microbiological growth. Nutrient addition and pH adjustment is also controlled for optimization of biological growth. Inside the reactors, flexible membrane diffusers, mounted on rotating rake arms, provide fine bubble aeration and turbulence for assuring a completely mixed reaction vessel. An agitator, incorporating an airlift, prevents the raked solids from settling. If necessary, the reactors can be sealed in which case all the reactor gases are vented through activated carbon prior to discharge. The treated fines are separated using polymer additions and clarifiers. If necessary, the settled solids are then dewatered using a plate and frame press or a belt filter press.

Depending upon the difficulty in biologically degrading specific target pollutants, several soil slurry bioreactors can be used in series. The slurry is reacted in the initial bioreactor, where easily degraded compounds are consumed by an acclimated biological community. Each successive reactor degrades the more refractory pollutants. It may also be advantageous to inoculate the bioreactors with microbes cultured from contaminated site soils since the indigenous microbial population can become naturally acclimated to the presence of the pollutants. By taking advantage of this natural selection process, it is possible to optimize the rate of degradation in the soil bioreactors. This process is specific for degradation of the organic portion of the washed fine fraction and would have little effect on the heavy metal pollutants concentrated in the fines. Therefore this unit operation will not be considered further.

There are several solidification/stabilization technologies that may be feasible for remediation, pending treatability testing (refer to Section 4.0). For the purposes of this report, portland cement will be used as a typical solidification technology because it is one of the more standard approaches. Solidification/Stabilization is a process in which the waste material is mixed with water, pozzolanic material such as portland cement, and proprietary additives. Lime or fly ash are typical stabilization reagents that may be added. The treated waste material is allowed to solidify into a specific block-size having significant unconfined compressive strength, physical stability and rigid, cement-like texture. This process decreases constituent mobility by binding constituents into a leach-resistant, concrete-like matrix while

increasing the waste material volume by approximately 50%. Solidification is expected to be completed at 75 ton/hour (tph) or about 50 cy/hr.

3.3.6 SC-5, Excavation of Debris Piles/Off-site Subtitle D Landfill/Cover NCFL and Ash Landfill Areas

This alternative involves excavation of the Debris Piles and disposal at an off-site Subtitle D Landfill. The areas designated as the Ash Landfill and the NCFL would remain in place and be covered with a soil cover, compacted, and vegetated to maintain cover stability and lower O&M costs. The rationale for this alternative is that the current concentrations of metals and SVOCs in soils do not pose an unacceptable human health risk based upon the baseline risk assessment. In addition, no ARARs are exceeded for on-site soils. As a result, the remedial action objectives are met and no further remedial action are required on this basis. However, the EPA has established a soil cleanup goal of 500 ppm for lead in soils for the protection of groundwater. The debris piles contain the highest concentration of lead and removal and off-site disposal of these areas represent a very cost-effective alternative to further reduce potential health risks and the potential for leaching and impacting groundwater. The installation and maintenance of a soil at the Ash Landfill and the NCFP would also further reduce potential health risks and the potential for leaching of metals to groundwater in these areas which contain lower concentrations of metals and SVOCs. The Debris Piles are well defined areas, easily accessible to excavation equipment and would not need any special requirements for excavation and removal. The Debris Piles would most likely meet all RCRA disposal requirements for landfilling off-site at a non-hazardous, Subtitle D landfill.

3.4 DESCRIPTION OF ALTERNATIVES FOR MIGRATION CONTROL

3.4.1 General

Migration control technologies have been grouped into alternatives, that will undergo the detailed screening process. These alternatives are:

• MC-1	No Action
• MC-2	Natural Attenuation/Degradation of the Plume/Institutional controls
• MC-3/MC-3a	Air sparging trenches/Funnel-and-Gate System/Iron filings
• MC-4	Interceptor trenches/Tank storage/Filtration/Liquid-phase activated carbon/Discharge to surface water
• MC-5	Interceptor trenches/Tank storage/Filtration/Air-stripping/Discharge to surface water

- MC-6 Interceptor trenches/Tank storage/Filtration/UV Oxidation/Discharge to surface water
- MC-7 Interceptor trenches/Tank storage/Filtration/Two-stage biological treatment/Discharge to surface water

The options selected will need to operate for a number of years to fully meet all of the remedial objectives. Estimates of the treatment time, capital costs, and annual O & M costs were also developed.

3.4.2 MC-1, No-Action

Under this alternative, the VOC groundwater plume would not undergo any active treatment considering the removal of the VOC source soils at the "Bend in the Road". The boundaries of the plume extend from an area immediately west of the former source areas near the "Bend-in-the-Road" westward approximately 200 feet beyond the SEDA fenceline (the toe of the plume). The remediation of the soils that contained the VOC source near the "Bend in the Road", is described in Section 1.6 of this report. The Ash Landfill RI (ES, 1994) describes the nature and extent of groundwater impacts and also includes estimates of the fate and transport of pollutants in the groundwater flow regime. The RI indicates that the groundwater plume consists of dissolved chlorinated organic solvents, mainly TCE and DCE. Although vinyl chloride was present in some wells near, or in, the source of the groundwater source area this compound was not detected in downgradient monitoring wells. This occurrence is not unexpected, since fugacity modelling predicted a stronger equilibrium partitioning to the vapor phase than both TCE and DCE and it is likely that this volatile compound would preferentially volatilize from the groundwater into the unsaturated soil pore space, and eventually be released to the atmosphere through the ground surface.

The occurrence of both dichloroethene and vinyl chloride implies that degradation due to biotic interactions is occurring. The presence of degradation products of TCE is consistent with known biological breakdown processes of TCE. Additionally, groundwater modelling performed as part of the RI, suggests that the degradation and transport processes may have achieved steady-state conditions. These processes include the transport of pollutants in the aquifer, the biodegradation of the pollutants and the continuous influx of pollutants into the system due to leaching. The suggestion that steady state conditions have been achieved is based upon groundwater monitoring data that has been collected since 1987. From a review of this data it appears that although there is some variation, the plume dimensions have not substantially changed and, therefore, steady-state conditions may have been reached. TCE enters the groundwater at the "Bend-in-the-Road" area, (which occurred only prior to completing the non-time critical removal action) and is being removed through dispersion and

biological action. In this naturally occurring cleansing process, TCE is biodegraded to vinyl chloride and is then removed from the aquifer due to volatilization. Because the VOC source has been eliminated, the concentrations of dissolved VOCs in groundwater on-site are predicted to decrease to levels below the Federal or NY State GA standards in approximately 15 years.

Since the risk assessment does not indicate unacceptable risk for current and intended future land uses, there is no requirement to conduct a remedial action. This is true providing that the groundwater is not used as a source of potable water. If the intended future land use involves residential use, then the risks would become unacceptable. Although current and intended land uses do not indicate unacceptable risks, groundwater quality standards have been exceeded. Since these values are promulgated by the State of New York, these groundwater quality requirements are considered to be ARARs and therefore a remedial action may be required to improve the groundwater quality although the concentrations of VOCs are expected to decrease below the groundwater quality standards by natural attenuation. This alternative will be carried through the feasibility analysis as a baseline to compare the benefits from other alternatives.

3.4.3 MC-2, Natural Attenuation and Degradation of the Plume/Institutional controls

This management of migration alternative is similar to the no action alternative, MC-1, with the added condition that institutional controls would be included to prevent exposure to groundwater.

According to the Interim Army Policy on Natural Attenuation for Environmental Restoration, the natural attenuation alternative is required to have (1) an extensive monitoring program to ensure that the natural processes are taking place and (2) a contingent remedy for the site. Quarterly monitoring is already in place for over 30 wells at the site. Continued groundwater monitoring will be performed, as has been done since 1987, to assure that the migration of chlorinated organics does not increase, especially in the direction of the nearest off-site receptors. This groundwater monitoring program will be conducted for 30 years. As part of the groundwater monitoring program for this alternative, groundwater monitoring wells will be installed along the boundary of the Ash Landfill which is adjacent to the farm and on the downgradient portion of the VOC plume. The groundwater data will be used to determine if there is a statistically significant upward or downward trend in the concentrations of VOCs in the groundwater. If the data indicate an upward trend in the concentrations of VOCs, a

contingency plan will be initiated. The contingency plan would include instituting deed restrictions to restrict well construction for drinking water, and supplying drinking water for off-site residences until the concentrations meet the NYSDEC GA criteria. The nearest residence, located on Smith Farm Road, has three wells that use both the overburden and the bedrock aquifer. The well, which uses the overburden aquifer, is used for farm purposes such as irrigation and not for drinking.

Another type of institutional control for the Ash Landfill is a deed restriction. This is more applicable as a source control measure but could be used to indicate that no drinking water wells should be constructed on-site. Additionally, an alternative water supply could be provided for any future residences at the Ash Landfill that would normally rely on groundwater.

3.4.4 MC-3/MC-3a, Air Sparging of Plume/Funnel-and-Gate System/Iron Filings

Air sparging is a technique that typically uses a large number of wells or a trench to inject air and nutrients into the groundwater plume at the bottom of the open well or trench. The treatment uses the concept of air stripping to remove volatile organic compounds. Under in-situ air sparging, air or oxygen is injected into the subsurface forcing contaminants to transfer from subsurface soil and groundwater into sparged air bubbles. The air streams are then transported to the soil pore spaces in the unsaturated zone, where they can be removed by soil vapor extraction.

An air sparging system generally consists of the following components: an injection well(s), air compressor, air extraction well(s), a vacuum pump, associated piping and valving for air movement systems, and an off-gas treatment system. Air injection wells are generally placed a few meters below the groundwater table to induce lateral spreading of air away from the injection well. As air moves through the groundwater zone, contaminants partition into the gas phase and are swept out of the groundwater zone to the vadose zone. At the same time, the oxygen in the sparged air partitions into the groundwater. The oxygen stimulates aerobic microbial degradation of contaminants. To prevent the unintended migration of contaminant vapors, sparging systems are usually integrated with an SVE system.

Air sparging depends on two basic processes for contaminant removal, volatilization and aerobic biogdegradation. The aeration of the groundwater that occurs as a result of air sparging can result in contaminant remediation via enhanced in-situ biodegradation when the

values for other relevant environmental parameters are in an acceptable range. In-situ air sparging systems should be designed and operated to optimize volatilization and biodegradation processes and to minimize the probability of adverse consequences such as off site migration of vapor or contaminated groundwater.

The advantages of in situ air sparging are that (1) a small volume of water must be treated per unit of time, (2) groundwater is not removed from the aquifer, and (3) the process does not draw large volumes of uncontaminated water into the zone of contamination.

An air sparging system, if properly designed, installed and operated, can potentially provide the most expedient and cost effective method for saturated zone soil and groundwater remediation. The effectiveness of air sparging is sensitive to the lithology and stratigraphy of the saturated and unsaturated zones. In fact, site geology is considered to be the most important design parameter. According to the EPA, one limitation of air sparging is that at present the technology is limited to coarser grained materials because coarse soils have lower air entry pressure requirements and provide a medium for more even air distribution. This allows better mass transfer efficiencies and more effective VOC removal. It is likely that air sparging will not be cost effective in fine-grained materials such as clays.

Long-term plume control can also be conducted using a funnel-and-gate system which consists of the use of low-conductivity cut-off-walls (funnel) to focus groundwater flow to a smaller in situ reactor (gate). The in situ reactor is the point of treatment using, in this case, either air sparging or iron filings for the removal of VOCs from groundwater. Several funnel-and-gate configurations may be used with the simplest being a single gate with cut-off walls extending to either side. The cut-off walls are extended to either side of the gate with funnels that have upstream projections and partially surrounding a contaminant source zone. Water infiltrates into the enclosure flows through the gate, where an in situ reactor treats the groundwater.

Advantages of using a trench system over a well for air sparging is the increase in exposure to the contaminated groundwater to be remediated. Vertical wells that have been used for air sparging applications have a very limited radius of effectiveness. Great efficiencies using in situ trenched air sparging can be achieved by constructing a trench and/or cut-off wall perpendicular to the groundwater flow direction, so that groundwater is forced to flow to the gate. Furthermore, treatment efficiency can be increased dramatically if groundwater flows through a gate whereby the configuration minimizes the amount of water that flows through the contaminated source zone and therefore the amount that must be treated and maximizes

the retention time in the gate leading to more complete treatment. Since the hydraulic conductivity of the soil is low at the Ash Landfill, the use of trenches and/or cut-off walls is preferred over wells. Two trench and/or cut-off walls one located just downgradient of the former source areas, and the other located at the toe of the existing plume, would be installed to the top of impermeable bedrock. Sheet piling may be installed in the trenches and backfilled with gravel or some other highly permeable material on the downgradient side of the sheet piling if a funnel-and-gate system was used.

3.4.5 MC-4, Interceptor trenches/Tank Storage/Filtration/Liquid-Phase activated carbon/Discharge to Surface Water

This alternative involves collection of groundwater using interceptor trenches, storing the collected water to account for any fluctuation in the influent flow, filtering the collected water to remove suspended matter that could cause clogging or excessive pressure drops across the activated carbon absorbers, removal of any dissolved organic pollutants using activated carbon, and discharging the treated effluent to the surface drainage ditch which would eventually flow to Kendaia Creek.

Since the saturated soils at the site are shallow and the hydraulic conductivity of the soil is low, the use of interceptor trenches is preferred over groundwater recovery wells. Interceptor trenches can be used to cut off the forward migration of a plume, or can be used in the middle of a plume to control the concentrated portion of the plume. For this application, the trench is expected to be 2 to 3 feet wide, dug to the top of the impermeable competent shale bedrock. The trench would be lined with a geotextile that will collect fine soil particles that could clog the drainage system. A perforated PVC pipe would be placed in the trench, and sloped to a low point collection sump. A number of sumps may be used depending on the natural slope and the length of the trench. The trench will then be filled with gravel or some other highly permeable material. The top 1 to 2 feet of the trench can be backfilled with the removed soil in order to minimize inflow of rainwater.

Tank storage can be used in several places in the treatment train. The most important use for tank storage is to equalize the flow between the interceptor trenches and the treatment train. The flow from the trench will vary depending on seasonal and weather conditions. The water can be pumped to an equalization tank from which it can be pumped at a consistent rate. This improves the efficiency of the treatment train because the treatment units are

optimized for specific flow rates. Tanks may be used at other locations in the treatment train if flow control is necessary to improve process performance.

Filtration is another important unit operation. Filtration will remove silt and precipitated metals such as iron prior to the organic treatment unit. This will help the efficiency of the organic treatment unit and provide for a better discharge. A variety of filters have been used in groundwater remediations, including in-line pressure filters, sand-bed filters, and multi-media bed filters. The specific filters used will depend upon the specifications of the organic treatment unit, and cost maintenance considerations.

This alternative utilizes activated carbon as the treatment technology. Activated carbon has been shown to be very effective in treating TCE and 1,2-DCE. However, carbon adsorption is ineffective for removing vinyl chloride and if the influent contains measurable concentrations of this component, carbon will be ineffective. Activated carbon has a high capacity to remove semi-volatile organics such as PAHs and phthalates and can also remove some metals. After pretreatment the groundwater is passed through carbon beds. The organic contaminants are adsorbed in the carbon and removed from the water. Over time, the adsorptive capacity of the carbon is diminished and the effluent concentrations will start to increase. At this point, new carbon beds will be provided and the spent carbon will be sent off-site for regeneration or disposal. On-site regeneration of the carbon is not considered in this analysis due to the small flows that are anticipated.

3.4.6 <u>MC-5, Interceptor trenches/Tank storage/Filtration/Air Stripping/Discharge to surface water</u>

For this alternative, groundwater would be collected by using interceptor trenches in the same manner as described for alternative MC-4. These trenches are ideal for conditions at this site since the groundwater movement is slow, i.e., less than 20 feet per year, and the aquifer thickness is small, i.e. between 2 to 6 feet depending upon the time of year. Hydraulically, interceptor trenches are analogous to an infinite line of extraction wells. These trenches will be placed perpendicular to the flow of groundwater, would extend across the entire width of the plume, and would collect groundwater continuously. Additionally, collections pipes placed at the bottom of each trench and sloped properly will allow the trenches to deliver the intercepted groundwater via gravity, thus simplifying the process and eliminating the need for multiple pumping stations. Only one pumping station would be required at the sump location for each trench used.

As with alternative MC-4, the collection trenches would discharge to a collection sump and be pumped to an on-site treatment facility. At the treatment facility, the collected water would accumulate in a tank that functions as a flow equalizer. Flow fluctuation are expected over the year due to varying aquifer thicknesses. This tank will be used as a buffer to allow the subsequent treatment unit operations to operate continuously and uniformly.

Filtration will be provided to remove any collected sediment and precipitated metals. It is common for dissolved metals, especially iron, to precipitate as insoluble oxides as the dissolved oxygen content of the collected groundwater increases due to exposure with ambient air. Clogging and coating of unit processes reduces treatment effectiveness and therefore sediment or precipitated metal oxides should be controlled via filtration.

For this alternative, air stripping is used as the treatment process that will reduce the concentration of dissolved chlorinated organics to meet the discharge standards. Air stripping is a common groundwater treatment process which is effective in treating TCE, 1,2-DCE and VC. Groundwater is passed through a stripping tower, where it is contacted by a countercurrent air stream. Trays or column packing is used to increase the surface area of the air/water contact area to improve the efficiencies of mass transfer operations. The organic constituents are transferred from the water to the air. Depending on the air emissions requirements, the air phase may be treated or directly discharged to the atmosphere. Air Emission control technologies include: vapor- phase activated carbon, thermal oxidation or catalytic oxidation. Vapor-phase carbon can be used to treat the off-gas in order to minimize air emissions. Vapor-phase carbon is efficient in capturing TCE and heavier organics but is less efficient at capturing DCE, and lighter organics. Carbon is inefficient in capturing vinyl chloride.

Thermal oxidation is another off-gas control technology which can be used to minimize air emissions. A thermal oxidizer works by combusting the off-gas. Thermal oxidizers are effective in treating all of the chlorinated compounds present in the Ash Landfill groundwater.

Catalytic oxidization is another off-gas treatment technology that could be considered for off-gas control. Catalytic oxidation is similar to thermal oxidation in that the organic compounds are thermally destroyed. An advantage of catalytic oxidizers over thermal oxidizers is that catalytic oxidizers operate at lower temperatures and therefore have lower operating costs. Catalytic oxidizers are effective in treating all the organics present in the site groundwater.

Occasionally, especially in long-term operations and with high concentrations of chlorinated compounds, the catalyst becomes fouled and must be replaced.

Following treatment, the effluent would be discharged to the nearby drainage ditches that exist along the sides of the patrol roads. Eventually the water drains to Kendaia Creek. In this case, the effluent would need to meet the requirements for a Class D surface water which is the classification of Kendaia Creek.

3.4.7 MC-6, Interceptor trenches/Tank Storage/Filtration/UV Oxidation/Discharge to surface water

Similar to alternatives MC-4 and MC-5, this alternative involves collecting groundwater using interceptor trenches and pumping the collected groundwater to an on-site treatment facility. The collected groundwater receives pretreatment including flow equalization from temporary storage and filtration to remove suspended sediment and any precipitated metal oxides.

Following the pretreatment of groundwater, this alternative utilizes liquid phase chemical oxidation from hydroxyl radicals, produced from the interactions of ultraviolet (UV) radiation and hydrogen peroxide, H_2O_2. Ozone may be added if treatment effectiveness is lower than required. This treatment process is proven to be effective in achieving greater than 99 percent destruction efficiency. Generally, using metering pumps, the contaminated groundwater is mixed with peroxide, and enters the UV reaction chamber. If required, ozone is added to the reaction chamber, and hydroxyl radicals are formed. The formation of the hydroxyl radicals is catalyzed by the UV light. The hydroxyl radicals react rapidly with the chlorinated organics, generating carbon dioxide, chloride and water. If ozone is added, any ozone not reacted is decomposed in an ozone treatment unit prior to discharge.

The effluent from the UV treatment process is then discharged to the drainage ditches that exist along the edge of patrol roads. This surface water eventually will flow to Kenadia Creek. This surface water discharge will need to meet the NYSDEC Class D stream classification quality standards for Kenadia Creek.

3.4.8 MC-7, Interceptor Trenches/Tank Storage/Filtration/Two-storage Biological Treatment/Discharge to Surface Water

This alternative involves collection and pretreatment of groundwater in a manner similar to alternatives MC-4, MC-5 and MC-6. This includes collection using groundwater interceptor trenches, flow equalization and filtration. Following pretreatment, contaminant removal involves a two-stage biological treatment process.

Biological treatment for groundwater contaminated with low concentrations of chlorinated organic compounds has not been typically performed. Recent advancements in this technology have produced positive results when both aerobic and anaerobic treatment processes are utilized. This process utilizes fluidized bed reactors to provide sufficient mixing between the contaminated groundwater and the biological substate. Biomass is allowed to grow and attach to a fluidized particle. Granular Activated Carbon (GAC) is typically used although sand has been substituted as an alternative.

The process utilizes a first stage anaerobic reactor to convert TCE and DCE to vinyl chloride. In the second stage methane is dissolved into the process water to stimulate the formation of methanogenic bacteria under aerobic conditions. The methanogenic bacteria are especially suited to degrade the vinyl chloride quickly. The result is that the dissolved chlorinated organics are degraded to water, carbon dioxide and hydrogen chloride. The process is considered innovative and does not have numerous full scale applications. Effluent from the process would be discharged to the drainage ditches that parallel the patrol road eventually discharging to Kenadia Creek.

3.5 SCREENING CRITERIA

3.5.1 General

The alternatives assembled for both source and migration control were screened as described in EPA guidance. These alternatives, listed on Tables 3-1 and 3-2, have been evaluated against short-term and long-term aspects of three broad criteria: effectiveness, implementability and cost. Because the purpose of screening is to reduce the number of alternatives that will undergo detailed analysis, the screening conducted in this section is of a general nature. Although this is necessarily a qualitative screening, care has been taken to ensure that screening criteria are applied consistently to each alternative and that comparisons have been made on an equal basis, at approximately the same level of detail.

3.5.2 Effectiveness

A key aspect of the screening evaluation is the effectiveness of each alternative in protecting human health and the environment. This screening criterion includes the evaluation of each alternative related to the protectiveness it provides and the reductions in toxicity and mobility.

- Short-term protectiveness of human health - Rating the potential for the remedial action to affect human health during remedial action. Both on- and off-site exposures are considered under this criterion. Exposure routes include inhalation, ingestion, and dermal absorption.

- Long-term protectiveness of human health - Rating the effectiveness of the remedial action to alleviate adverse human health effects after the remedial action is complete. The ability of an alternative to minimize future exposures is considered under this criterion. Exposure routes include inhalation, ingestion, and dermal absorption.

- Short-term protectiveness of the environment - Rating the effectiveness of the remedial action to prevent environmental receptors from being affected by constituents during remedial action.

- Long-term protectiveness of the environment - Rating the effectiveness of the remedial action to prevent environmental receptors from being affected by constituents after remedial action is completed.

- Reduction of mobility, toxicity, or volume of waste - Rating of effectiveness in changing one or more characteristics of the medium by treatment to decrease risks associated with chemical constituents present.

3.5.3 Implementability

Implementability is a measure of both the technical and administrative feasibility of constructing and operating a remedial action alternative.

- Technical feasibility - Rating of the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete. That also includes monitoring of the alternative, if required, after the remedial action is complete.

- Administrative feasibility - Rating of the ability to obtain approvals from regulatory agencies and the Army; the availability of treatment, storage, and disposal services; and the requirements for, and availability of, specific equipment and technical specialists.

3.5.4 Costs

Both capital and operation and maintenance costs have been considered during the screening of alternatives.

- Capital costs - these were estimated based on order-of-magnitude vendor unit costs or currently, best-available standard references.

- Operating and maintenance (O&M) costs - O&M costs were evaluated by assigning a rating value ranging between 1 and 5 as described in the following paragraph.

3.5.5 Numeric Rating System

The alternatives were evaluated by applying a simple numeric rating system. Each alternative was assigned a value ranging between 1 and 5 for a particular criteria. The value assignments were based on both experience and the overall characteristics of the alternatives. If a specific alternative was considered very unfavorable for a given criteria a value of 1 was assigned relative to the other alternatives within the criteria. Likewise, if a particular alternative was considered very favorable, a rating value of 5 was assigned to it relative to the other alternatives within that criteria. Rating scores of 2 through 4 were given to distinguish varying degrees of unfavorable and favorable alternatives. The individual criteria values were summed for each alternative and the totals used to screen alternatives.

3.6 SCREENING OF SOURCE CONTROL ALTERNATIVES

3.6.1 Method

The alternatives screening process is presented on Table 3-3. Screening was conducted by considering one column (one criteria) at a time, independent of the other columns and

TABLE 3-3
SCREENING OF SOURCE CONTROL ALTERNATIVES

ALT.	TECHNOLOGY AND PROCESSES	EFFECTIVENESS									IMPLEMENTABILITY				COST		SCORE
		PROTECTIVENESS				REDUCTIONS			PER-MAN-ENCE	ARAR COMP-LIANCE	Feasibility		Feasibility				
		Human Health		Environment													
		short-term	long-term	short-term	long-term	Tox.	Mob.	Vol.			Construct-ability	LONG-TERM MONIT.	AGENCY APPROV.	AVAIL.	CAPIT.	O&M	
SC-1	No action	5	1	5	1	1	1	1	1	1	5	5	1	5	5	5	43
SC-2	Excavation of both the Ash Landfill and the NCFL/ off-site disposal	1	2	1	5	2	2	1	2	2	3	5	2	5	2	4	39
SC-3	Excavation/consolidation to the NCFL/Cap NCFL	3	2	3	2	2	3	2	3	2	3	3	3	4	3	2	40
SC-4	Excavation/wash/backfill coarse frac./solidify fine frac./on-site landfill	2	4	2	4	4	5	4	4	4	1	3	4	1	1	2	45
SC-5	Excavation/off-site Subtitle D Landfill/Cover NCFL and Ash Landfill Areas	4	3	4	3	2	3	2	3	2	3	3	3	4	4	3	46

relative to the other alternatives, particularly the no-action alternative. The first step was to review each alternative and identify the alternatives that represent the two extreme values (1 and 5). The values were applied consistently in an unbiased manner to each alternative on this column-by-column basis. The following subsections present the qualitative rationale that were utilized to assign values to each alternative.

3.6.2 Effectiveness

3.6.2.1 Short-Term Human Health Protectiveness

Since current and intended future land uses do not exceed EPA target risk criteria, the no-action alternative, SC-1, is considered most protective of human health in the short term and was given the ranking of 5. This site has restricted access control, which minimizes unauthorized human exposure from dermal contact and the ingestion of soil.

Each of the remaining four alternatives (SC-2, SC-3, SC-4 and SC-5) involves excavation of soil. Excavation would lower short-term worker protectiveness relative to no-action, even with dust controls and personal protection equipment, because it causes an increase in concentrations of semi-volatiles and particulates when compared to not excavating.

Alternatives SC-2, SC-3, SC-4 and SC-5 which involve excavating and processing all contaminated materials on the site, were ranked upon the amount of excavation that is expected to occur. Alternative SC-3 and SC-5 involves limited excavation and consolidation in the NCFL, and was ranked higher since the amount to be excavated or disturbed is smaller than for alternatives SC-2, and SC-4. Alternative SC-2 and SC-5 involves not only excavation but also off-site transportation of contaminated soils and was given the lowest ranking value of 1. SC-4 were given a ranking of 2.

Although all materials will be excavated, the excavation process will be done in limited quantities since soil washing can only process approximately between 10 to 20 tons of material per hour. Further, soil washing processes are wet processes that will greatly reduce the potential for exposure to particulates for on-site workers.

3.6.2.2 Long-Term Human Health Protectiveness

Alternative SC-1, no-action, is considered to pose the greatest long-term human health risk due potential exposure to metals and PAHs in the soil. This alternative was given a ranking

of 1. All other alternatives are more protective of human health in the long term, than the no-action alternative since each alternative diminish the potential exposure of a site worker or a future resident to contaminated soil or groundwater.

Alternative SC-4, which involves soil washing followed by solidification of the fines, is was assigned a ranking value of 4 because non-volatile pollutants are eliminated from exposure potential. Alternative SC-3, which involves consolidation of contaminated materials and capping in the NCFL, is given a ranking value of 2 since this alternative does not destroy pollutants but will contain the pollutants for a long period of time. Maintenance of the cap and long term monitoring is required to assure the continued isolation of the capped materials. SC-2 and SC-5 also received a ranking of 2.

3.6.2.3 Short-Term Environmental Protectiveness

Since the no-action alternative does not involve excavation there is no potential for causing increased exposure due to excavation or short-term discharges from remedial activities. There are currently no observable acute environmental effects caused by contaminants at the Ash Landfill site. Therefore, the no action alternative, SC-1, has been given a ranking value of 5.

All other alternatives (SC-2 through SC-5) require excavation and are considered to be less protective of the environment in the short-term. Remedial activities that require excavation are considered to be a negative factor since excavation will destroy plant species and will be disturbing to the local wildlife due to the increase in heavy equipment noise and odors. This factor has been considered by ranking those alternatives that require the most excavation the lowest.

The highest ranked alternative for this category other than no-action is SC-5, which involves the smallest amount of excavation at the Ash Landfill area. As a result, this alternative produces the least disruption to the environment and was assigned a ranking value of 4. Alternative SC-3 was assigned a ranking value of 3 since it requires a greater amount of excavation.

Alternative SC-4, which involves excavating and processing all contaminated materials on the site, was ranked low for short term protection and it was given a ranking value of 2. Soil washing plants can process between 10 to 20 tons of material per hour. As a result, the

excavation and processing time would be the greatest compared to the other alternatives, increasing the disruption to the local wildlife.

Alternative SC-2, was given the lowest ranking value of 1 since material from all areas, including the debris piles, the ash landfill, the NCFL, and the "Bend-in-the-Road" area, would be excavated and transported off-site, thereby causing the greatest amount of environmental disturbance.

3.6.2.4 Long-Term Environmental Protectiveness

Alternative SC-1, no-action, is the least protective of the environment over a long time period due to potential continued erosion and exposure of hazardous contaminants. The other alternatives are more protective of the environment in the long-term since contaminants are either removed, treated, stabilized or isolated so that continued environmental exposure is reduced or eliminated. Those alternatives that remove or destroy the constituents of concern are ranked higher, i.e. more favorable, than those alternatives which stabilize or isolate pollutants on-site because of the small possibility that, over the long term, these pollutants could be re-released to the environment.

Alternative SC-2, excavation/off-site disposal, was given the highest ranking of 5 because all contaminated materials are removed from the site thereby assuring long-term protectiveness of the environment. Alternative SC-4 (excavation/washing/solidification/on-site landfilling) is ranked the next highest with a score of 4 since the volume of contaminated materials is reduced but it still remains on the site. Alternative SC-5 was assigned a value of 3 since it disposes off-site the soils containing the highest concentrations of lead. Alternative SC-3 was given a value of 2 since it only isolates contaminated materials via a cap without solidifying or destroying them.

3.6.2.5 Reduction In Toxicity

Alternative SC-1 does not reduce toxicity and was therefore assigned a ranking value of 1. Alternative SC-2 does not include any treatment and was ranked low, with a ranking value of 2, because although there is no reduction in toxicity the materials have been removed to a secure landfill. Alternative SC-5 was ranked higher than alternatives SC-2 and SC-1 even though it does not include any treatment techniques. The reason for this is because the magnitude of the excavation is smaller in SC-5 than in SC-2 and SC-3, which includes

consolidation of toxic materials, elimination of exposure routes and a decrease in the widespread dispersion of these materials around the site. Alternative SC-3 was assigned a ranking value of 2 and alternative SC-2 was ranked 2.

Alternative SC-4 will reduce toxicity by reduction of contaminant mobility. SC-4, the washing/solidification alternative, was ranked with a 4 because this alternative will reduce the toxicity of metals and semi-volatiles with most permanent solution. This alternative will also reduce the volume of material that will need to be solidified and will reduce the toxicity of the coarse washed materials through treatment of the wash water.

3.6.2.6 Reduction In Mobility

The factors that were used in the ranking of these alternatives include the amount of excavation required, control of surface water erosion and a decrease in the concentration of constituents in the soil that could be potentially mobile. During the excavation of soil, the mobility of materials may be increased due to the interaction of precipitation causing surface water runoff or due to wind erosion. The no-action alternative, SC-1, ranked the lowest with a value of 1 because there is no reduction in mobility. Alternative SC-2 was ranked slightly higher with a value of 2 because the constituents of concern will be removed to an off-site landfill. This alternative was not ranked higher because it requires a large amount of excavation of material that would be undisturbed under the no-action alternative. Alternative SC-3 and SC-5 were ranked higher than SC-2, with a value of 3. SC-3 and SC-5 would reduce the mobility of materials by decreasing the amount of material that would be excavated. Capping prevents leachability of materials from the landfill thereby reducing the mobility of materials. The remaining alternative, SC-4, will reduce contaminant mobility via soil washing, removing and destroying the organic contaminants and solidifying the remaining fines. The fines will contain the contaminants of concern, such as the PAHs, in addition to the metals but solidification is considered to be the best alternative for reducing mobility of the remaining residual materials. SC-4 was given a ranking of 5.

3.6.2.7 Reduction in Volume

Alternatives SC-1, no action, and, SC-2, off-site disposal, were ranked low because there is no volume reduction associated with these alternatives; they were both ranked 1. Alternative SC-3 does not produce any volume reduction but does consolidate source materials from several dispersed areas of the site and allow for better management of these materials. This

alternative was ranked 2, which is higher than SC-1 and SC-2. Alternative SC-5 was also assigned a ranking value of 3 since it is similar in scope to SC-3. Alternative SC-4 will reduce the volume of materials by soil washing, which removes organic contaminants and treats the wash solution. The remaining volume of fines, which contain the majority of the contaminants of concern, is then solidified resulting in an increase in the volume, but overall the volume of contaminated material is reduced. SC-4 was ranked 4.

3.6.2.8 Permanence

No-action (SC-1) is the least permanent alternative and was ranked the lowest with a value of 1. The alternatives SC-2 and SC-3 were ranked 2 and 3, respectively, because these alternatives involved landfilling or capping, which are not considered permanent because landfills have a finite design life. SC-5 was assigned a ranking value of 3 since it is similar in scope to SC-3. Alternative SC-4 includes solidification/ stabilization and is considered to be more permanent than the landfilling and capping alternatives. This alternative was ranked with a value of 4.

3.6.2.9 ARAR Compliance

There are no ARAR's for soil remediation which specifically provide promulgated cleanup standards. The November 16, 1992, NYSDEC TAGM HWR-92-4046 titled "Determination of Soil Cleanup Objectives and Cleanup Levels" has been identified as a To Be Considered (TBC) for soil remediation levels. Comparing the NYSDEC TAGM values with the 95th UCL of the mean of the surface soil concentrations indicates that, volatile organics, PAH compounds Benzo(a)anthracene, Benzo(a)pyrene and Dibenzo(a,h)anthracene and the metals cadmium, chromium, copper, lead and zinc currently exceed the appropriate TAGM values. The alternatives, SC-2, SC-3 and SC-5 do not actually reduce the concentration of the components to levels below the TAGM values, but through containment in landfills or capping, provide a higher degree of protection and were rated higher than the no-action alternative with a value of 2. SC-4 was ranked as a 4 since it includes soil washing and solidification which would be effective for reducing metals and semi-volatile organics concentrations.

3.6.3 Implementability

3.6.3.1 Constructability

No-action (SC-1) received the highest ranking since it does not require any design and construction. For the alternatives that require construction, the alternative SC-5, excavation, consolidation and capping, received a rating of 4 because this alternative requires the smallest amount of material to be excavated and requires a soil cover to be constructed. Capping or covering is considered to be a standard technology that is easy to construct in most cases. SC-3 was also assigned a value of 3 due to the requirement of installing a clay instead of the soil cover in SC-5. The off-site disposal alternative, SC-2, was ranked the same as SC-3, with a value of 3, because of the difficulty in potential excavating and transporting of hazardous materials. The potential construction issues which were considered in this evaluation included heavy equipment decon stations, construction workers showering and changing stations, runoff/runon control structures, air emission monitoring stations, temporary groundwater dewatering treatment plants, soil handling facilities and transportation route planning. The washing/solidification alternative, SC-4, is considered to be an innovative technology and is more likely to encounter difficulties during construction and operation due to uncertainties associated with successfully processing landfill debris and soils with a high clay content. This is particularly true because of the complexities associated with selecting the optimal solidification mixture and assuring a uniform solidification matrix and was ranked the lowest with a value of 1.

3.6.3.2 Long-Term Monitoring

Alternative SC-1, the no-action alternative, requires no long term monitoring of soils and is the easiest to implement and, therefore, was ranked the highest with a value of 5. Alternative SC-2, the off-site landfill alternative, was also ranked high because once the material is properly disposed of the long term monitoring requirements are not the responsibility of SEDA but rather the landfill operators. Alternative SC-4, which includes soil washing and solidification of the fines, was ranked with a 3 because some monitoring of the soils left on-site may be required. Alternative SC-3 and SC-5 were also ranked with a 3 because these alternatives would require monitoring of the integrity of the cap and groundwater.

3.6.3.3 Agency Approval

The no-action alternative (SC-1) was ranked the lowest since it may be the most difficult alternative to receive agency approval because the soil TAGM values are exceeded. The remaining alternatives least likely to be approved by NYSDEC and EPA are the cap and off-site landfill alternatives, SC-2 and SC-3. This is because these alternatives rely either on transferring the waste to an off-site landfill, which general EPA policy discourages, or utilizes a cap alternative which EPA policy considers to be a temporary solution. EPA typically prefers permanent solutions at CERCLA sites. These alternatives were ranked 2 and 3, respectively. SC-5 was also ranks as a 4 for the same reasons. The washing alternative, SC-4, which combines on-site soil washing with solidification, was ranked with a value of 4 because this alternative is effective for non-volatile organics and metals.

3.6.3.4 Availability

The no-action alternative, SC-1, and the off-site landfill alternative, SC-2, are the least affected by availability and were ranked equally high; both received a 5. Alternative SC-3 and SC-5 were ranked with a value of 4 since the technologies required for these alternatives are readily available.

Alternative SC-4 was ranked lowest with a 1. Soil washing capabilities are provided by several US vendors who have licensed European technologies: The availability of these limited number of vendors compared to capping or landfilling vendors is considered to be significantly less attractive because of the specialization required to properly implement soil washing.

3.6.4 Costs

3.6.4.1 Capital Cost

Order of magnitude unit costs were estimated based on best-available information for the technologies utilized in the five alternatives and are summarized in Table 3-4. These costs serve as the basis for ranking these alternatives as shown in Table 3-3. The no-action alternative (SC-1) was ranked the highest because there are no capital or operating costs associated with this alternative. SC-5 received the next highest ranking since the estimated

TABLE 3-4
SCREENING OF MIGRATION CONTROL ALTERNATIVES

ALT.	TECHNOLOGY AND PROCESSES	EFFECTIVENESS									IMPLEMENTABILITY				COST		SCORE
		PROTECTIVENESS				REDUCTIONS			PER-MAN-ENCE	ARAR COMP-LIANCE	TECH. FEASIB.		ADM. FEASIB.				
		Human Health		Environment							CON-STRUC.	LONG-TERM MONIT.	AGENCY APPROV.	AVAIL.	CAPIT.	O&M	
		short-term	long-term	short-term	long-term	Tox.	Mob.	Vol.									
MC-1	No action	4	1	4	1	1	1	1	1	5	5	5	1	5	5	5	45
MC-2	Natural attenuation of plume/ institutional controls	5	2	5	2	1	2	1	2	5	5	1	2	4	4	4	45
MC-3/	Air sparging of plume/funnel-	3	3	2	3	2	3	2	3	5	2	2	3	3	2	1	39
MC-3a	and gate system/Iron filings	3	3	2	3	2	3	2	3	5	3	2	3	3	4	5	46
MC-4	Interceptor trenches/tank storage/ filtration/liquid-phase carbon/ surfacewater discharge	3	4	3	4	4	4	4	3	5	4	3	4	2	2	1	50
MC-5	Interceptor trenches/tank storage/ filtration/air stripping/surfacewater discharge	2	4	3	4	3	3	4	3	5	4	5	4	2	3	3	52
MC-6	Interceptor trenches/tank storage/ filtration/UV Oxidation/ surfacewater discharge	3	5	3	5	5	5	5	5	5	3	4	5	2	3	3	61
MC-7	Interceptor trenches/tank storage/ filtration/two-stage bio. treatment/ surfacewater discharge	3	4	2	4	5	5	5	4	5	1	3	3	1	1	2	48

costs for this alternative are the lowest of the four remaining alternatives. Alternative SC-3, consolidation and capping, was ranked with a 3 since it has the next lowest cost. SC-2, the off-site disposal, was ranked with a 2 since it has the next lowest capital costs. SC-4 was ranked the lowest since this alternative has the highest capital cost.

3.6.4.2 Operation and Maintenance Costs

Long-term O&M costs, which are incurred after the remedial action is completed, are addressed using the ranking system based upon the quantitative estimate of O&M costs presented in Table 3-4. The no-action alternative, SC-1 and the off-site disposal alternative, SC-2, have no long-term O&M costs and are ranked the highest with a 5 and a 4, respectively. SC-3 was assigned a value of 3 since it has the next lowest O&M costs that are associated with maintenance and monitoring of the landfill covers. Alternative SC-2 was ranked with a 4 because there may be some small costs associated with maintaining the equipment during the performance of the remedial action. The consolidation and the on-site landfill alternative, SC-3, and the soil washing and on-site solidification alternative, SC-4, have been ranked with a 2 because of the need to perform landfill cap maintenance and monitoring.

3.6.5 Scoring

Alternatives SC-1, SC-2, SC-3, SC-4 and SC-5 were retained for analysis in Section 5.0 because all the alternatives scored within 7 points of each other. Furthermore, SC-1 was retained because it is the no-action alternative; SC-2 because it is an off-site remedial alternative; SC-3 because it is the highest ranked capping alternative; and SC-4 because it is the highest ranked alternative for metals and semi-volatile organic control.

3.7 SCREENING OF MIGRATION CONTROL ALTERNATIVES

3.7.1 Method

The alternatives screening process is presented on Table 3-5. Screening was conducted by considering one column (one criteria) at a time, independent of the other columns and relative to the other alternatives, particularly the no-action alternative. The first step was to review each alternative and identify the alternatives that represent the two extreme values (1 and 5). The values were applied consistently and unbiasedly to each alternative on this

Table 3-5
Summary Cost Breakdown for Source Control Alternatives

SOURCE CONTROL (SC) ALTERNATIVES

Alternative Number	Description	Capital Cost	O&M Present Worth	Total Present Worth Cost
SC-1	No-Action	$0	$0	$0
SC-2	Off-Site Disposal	$17,500,000	$0	$17,500,000
SC-3	Consolidate and Cap	$1,370,000	$490,000	$1,860,000
SC-4	Soil Washing & Solidification	$31,500,000	$490,000	$32,000,000
SC-5	Off-site Disposal Debris Piles Only/Cover	$237,063	$490,000	$727,063

column-by-column basis. The following subsections present the qualitative rationale that were utilized to assign values to each alternative.

3.7.2 Effectiveness

3.7.2.1 Short-Term Human Health Protectiveness

Alternative MC-2, the natural attenuation alternative, is considered to be the most protective of short-term human health since it has been demonstrated from an extensive groundwater monitoring program, initiated in 1987, that there is no current ingestion of contaminated groundwater. This alternative includes continuation of the groundwater monitoring program and land use restrictions. The remainder of the alternatives (MC-1 and MC-3 through MC-7) are considered to be slightly less protective of short-term human health since there is a slightly increased potential of exposure to the influent groundwater stream or the effluent air and water treatment flow.

MC-1 was given the next highest ranking of 4. Each of the groundwater collection and treatment alternatives (MC-4 through MC-7) will require excavations to be conducted within the groundwater plume, using interceptor trenches. It is anticipated that these excavations would be conducted in areas of low contaminant concentrations, so that the threat to human health and the environment would be minimal. These alternatives were ranked between 2 and 3.

The lowest scoring alternative is MC-3, the air sparging alternative, due to the uncertainties with sparging volatiles from the groundwater into the ambient air; it received a ranking of 1. This would increase the potential for exposure. This potential exposure is likely to be small since the concentration of volatiles in the groundwater plume is in the parts-per-billion (ppb) range.

3.7.2.2 Long-Term Human Health Protectiveness

Alternative MC-1, no-action, ranks the lowest of the alternatives for long-term protection of human health. Since there is no treatment of the organics in the plume, there is a potential for long-term exposure from domestic off-site use of the shallow groundwater. However, although there is a possibility for off-site use of groundwater as a source for potable water, the Groundwater Modeling study at the Ash Landfill showed that the plume would move very

slowly and the VOC concentrations would decrease in the plume with time; the size of the plume would also be significantly reduced over time.

Most of the other alternatives rank fairly high on long-term protectiveness of human health. Alternative MC-6 was ranked high with a 5 because this process destroys the pollutants. Generally, due to the slow movement of groundwater, groundwater treatment times can extend for several years before the concentrations in the groundwater reach levels at which treatment is no longer required. The time to achieve a prescribed cleanup goal has been decreased because the source of the groundwater plume has been removed, preventing continued impacts to the groundwater. Alternative MC-2, which uses natural attenuation and institutional controls, ranks lower because this alternative does not utilize a treatment technology although pollutants are reduced in a passive system. Alternative MC-7, which uses biological treatment, was ranked high with a 4 because contaminants are destroyed. It was ranked lower than MC-6 because MC-7 is not as proven a technology as UV oxidation.

3.7.2.3 Short-Term Environmental Protectiveness

The natural attenuation/institutional control alternative (MC-2) is considered to be the most protective of the environment in the short-term because the current risk assessment does not indicate unacceptable risks. This alternative is ranked higher than no-action alternative (MC-1) because it includes groundwater monitoring and institutional controls that are not included as part of MC-1. There are currently no adverse effects on the environment due to the groundwater. All the other alternatives (MC-3 through MC-7) rank slightly lower because of the disruptions created by construction. The potential for releases during implementation of these alternatives is very small.

3.7.2.4 Long-Term Environmental Protectiveness

The rankings for long-term protectiveness of the environment are essentially identical to the rankings for long-term protectiveness of human health, as described above. The no-action alternative, MC-1 scores the lowest, while all the other alternatives (MC-2 through MC-7) score higher.

3.7.2.5 Reduction In Toxicity

Alternatives MC-1, no-action, and MC-2, institutional controls, scored the lowest because there is no treatment other than natural degradation; they were both ranked 1. Alternative MC-6, UV Oxidation, and alternative MC-7 score the highest (both received a 5) because the organic constituents are destroyed on-site. Alternative MC-3, air sparging of the plume, score relatively low (2) due to the uncertainty associated with pollutants being released to the

atmosphere. MC-5, air stripping, was ranked higher than MC-3 because the pollutants could be released to the atmosphere if emission controls failed; MC-5 and MC-3 were ranked 3 and 2, respectively.

3.7.2.6 Reduction In Mobility

Reducing the mobility is an important consideration for migration control. The no-action alternative, MC-1, ranks the lowest with a 1 since there is no reduction in mobility. Alternatives MC-6 and MC-7 were ranked the highest with a 5 because contaminants are destroyed and there is a significant reduction in mobility. Alternative MC-2 was ranked a 2 since groundwater monitoring will be combined with the natural attenuation alternative to monitor mobility not control it. Alternative MC-3, air sparging, and MC-5, air stripping, scored with a 3 because of the potential for contaminants to be mobilized if released to the air. MC-4 was ranked with a 4 because contaminants are not destroyed but only transferred.

3.7.2.7 Reduction in Volume

Most of the migration control alternatives provide adequate reductions in volume, with the exception of alternatives MC-1, no action, and MC-2, which rely on natural attenuation. The time required for cleanup is much greater than for the other alternatives. For migration control, it is better to think of volume reduction with regards to decreasing the mass of the hazardous constituents, or decreasing the volume of the groundwater that exceeds the NYSDEC Class GA groundwater standards. In this respect, all of the other alternatives are fairly equal. The major difference between the alternatives is in the volume of treatment residuals. Alternatives MC-6 and MC-7 score slightly better than alternatives MC-4 and MC-5 because these alternatives destroy pollutants rather than transferring the pollutants to another media.

3.7.2.8 Permanence

Alternative MC-6, UV Oxidation, scores the highest, because treatment is achieved in a timely manner, and the constituents are converted to non-hazardous compounds. Alternative MC-7 scores almost as high with a 4 because MC-7 produces the complete destruction of the organics on site although the technology is not yet proven. The other alternatives score slightly lower.

3.7.2.9 ARAR Compliance

All alternatives have equal rankings because each alternative will comply with all ARARs. Any difference between the alternatives is the time-to-compliance. In the case of MC-1 and MC-2, the natural attenuation process will take 15 years to achieve the groundwater standards for VOCs in the on-site plume.

3.7.3 Implementability

3.7.3.1 Constructability

Alternatives MC-1 and MC-2 rank the highest because they require the least construction. Alternative MC-3, air sparging, was ranked low with a 2 due to the uncertainty regarding the construction of air sparging trenches and cut-off walls that will need to be installed. Alternatives MC-6, UV oxidation, ranks slightly higher with a 3 because the UV system will draw large amounts of electrical power, requiring increased construction complexity. Additionally, because these systems have electrical components, they must be protected from adverse environmental conditions and require a building, thereby increasing construction complexity. Alternatives MC-4, liquid-phase carbon, and MC-5, air stripping, scored slightly higher with a 4 because these technologies include equipment that is readily available and has no special environmental restrictions. All of the groundwater pump and treat alternatives, MC-4, MC-5, MC-6 and MC-7, will require the installation of a groundwater recovery system which will increase the difficulty to construct these alternatives, but since this issue is common to each alternative, this issue does not increase the difficulties to construct any one alternative more than another. Alternative MC-7 scores the lowest with a 1 because the two-stage biological treatment alternative is innovative and uncertainties exist as to construction issues.

3.7.3.2 Long-Term Monitoring

All of the alternatives require long-term monitoring of the groundwater to determine the effectiveness of the treatment process. Alternatives MC-1 does not include a monitoring program and, therefore, was ranked the highest with a 5 since this alternative is the easiest to implement. Alternative MC-2 was ranked the lowest with a 1 since this alternative requires the longest time for monitoring because this alternative utilizes natural degradation to achieve remedial action objectives. Alternative MC-3, air sparging of the plume, was ranked with a 2 due to the uncertainties associated with achieving remedial action objectives with an in-situ alternative. Monitoring of the effectiveness of treatment will likely be required for this alternative over the area of sparging. Alternatives MC-4, liquid phase carbon adsorption, and

MC-7, two-stage biological treatment, were both ranked with a 3 since these technologies would require frequent monitoring of the plant effluent to determine the need to change the carbon columns or that the biological treatment process is effective. Alternative MC-6, UV oxidation, accomplishes a high degree of treatment on site, and would require some monitoring of the effluent but not as much as MC-4 or MC-7 and was ranked higher with a value of 4. Alternative MC-5 was ranked the highest (5) because this process is considered the simplest and most reliable to operate and, therefore, will not require a large amount of monitoring.

3.7.3.3 Agency Approval

Most of the alternatives are similar, in that they are "pump-and-treat" technologies, and are almost equally likely to be approved by the agencies. Alternative MC-1, no-action, was ranked the lowest since groundwater standards for Class GA have been exceeded, thereby requiring some remedial action. Alternative MC-2, natural attenuation and institutional controls, was ranked higher than MC-1 with a 2 because of the uncertainty in achieving GA standards and the agency concern that the plume may continue to move off-site and impact off-site wells. Alternatives MC-3 and MC-7 were ranked higher than MC-2 with a 3 because there is more uncertainty associated with an in-situ alternative, i.e.,MC-3, and an innovative alternative, i.e.,MC-7 than other ex-situ treatment alternatives. Alternatives MC-4 and MC-5 were ranked high with a 4 because these alternatives include standard treatment technologies that are proven to be effective in reducing volatile organics in groundwater and have been approved by regulatory authorities in the past. Alternative MC-6 was ranked the highest since this technology destroys the contaminant in the liquid phase, does not produce air emissions, and is considered to be a proven technology. This alternative was ranked the highest with a 5 because it is considered the easiest for agency approval.

3.7.3.4 Availability

The no-action alternative, MC-1, was ranked the highest since it is readily available. MC-2, natural attenuation/institutional controls, was also ranked high with 4 because it is also readily available to implement. Availability is very good for all the remaining alternatives (MC-3 through MC-7), since most rely on standard technologies. However, alternative MC-7, two-stage biological treatment, scores the lowest of these because of the lack of full-scale systems currently in use.

3.7.4 Costs

3.7.4.1 Capital Cost

Capital costs were also estimated for each of the seven migration control alternatives and are presented in Table 3-6. These costs are based on the unit costs for each treatment technology provided in Appendix D. The ranking of the alternatives are based upon these capital costs. MC-1 the no-action alternative, was ranked the highest since these costs are zero. MC-2 was ranked with a 4 since these costs were the next lowest. MC-5 and MC-6 were both ranked with a 3 since these costs were the next highest and were similar in cost. MC-3 and MC-4 were ranked with a 2 since they were the next highest capital costs. MC-7 was ranked the lowest with a 1 since this alternative had the highest capital cost.

3.7.4.2 Operation and Maintenance Cost

Annual O&M costs are an important part of evaluating migration control alternatives. Groundwater treatment often takes 20 to 30 years, and O&M costs can become significant. O&M costs were estimated as described in Appendix D and are summarized in Table 3-5. Costs for alternative MC-1, the no action alternative, were ranked the highest since there are no costs. The costs presented in Table 3-5 were used as the basis for the ranking presented in Table 3-4. MC-2 was ranked the next highest since the costs were the next to lowest. MC-5 and MC-6 were each ranked with a 3 since these costs were similar. MC-3 and MC-4 were ranked the lowest with a 1 since these costs were the highest.

3.7.5 Screening

Alternatives MC-2, MC-3, MC-5 and MC-6 were retained and alternatives MC-1, MC-4, and MC-7 were screened out. Alternative MC-2 was retained since it is similar to the no action alternative and provides monitoring of site conditions whereas MC-1 does not; MC-3 because it is the only in-situ alternative and it is the highest ranked of the non-pump and treat alternatives; and MC-5 and MC-6 because they are the highest ranked pump and treat alternatives.

Table 3-6

MIGRATION CONTROL (MC) ALTERNATIVES

Alternative Number	Description	Capital Cost	O&M Present Worth	Total Present Worth Cost
MC-1	No-Action	$0	$0	$0
MC-2	Natural Removal/ Institutional Controls	$160,000	$794,000	$954,000
MC-3	In-Situ Air Sparging	$668,000	$1,790,000	$2,458,000
MC-3a	Funnel and Gate System/Iron Filings	$422,00	$601,622	$1,023,622
MC-4	Liquid Phase Carbon Adsorption	$668,000	$1,703,000	$2,371,000
MC-5	Air Stripping	$543,000	$1,222,000	$1,765,000
MC-6	UV Oxidation	$556,000	$1,308,000	$1,864,000
MC-7	Two Stage Biological Treatment	$710,000	$1,492,000	$2,202,000

4.0 TREATABILITY STUDIES

4.1 INTRODUCTION

An important aspect of many remedial actions is the treatability study. In general, there are two primary objectives for treatability studies:

- Gather sufficient data to allow treatment alternatives to be fully developed and evaluated and to support the remedial design of a selected alternative.

- Reduce cost and performance uncertainties for treatment alternatives.

There are three stages in the CERCLA process in which treatability studies may be used; remedy screening, remedy selection, and remedy design. In the remedy screening phase, treatability studies are designed to establish whether or not a technology can effectively treat a given waste. These studies generally provide little cost or design data. In the next stage, remedy selection, treatability studies are used to evaluate the site-specific performance of each technology in order to support selection of an alternative. Treatability studies in the remedy selection stage will yield information on 7 of the 9 technology evaluation criteria (EPA, 1991b), including:

- Overall protection of human health and the environment
- Compliance with ARARs
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Long-term effectiveness and permanence
- Cost.

This mid-stage of the CERCLA process is generally implemented prior to the Record of Decision (ROD) and would be referred to as a pre-ROD treatability study.

The last stage of the CERCLA process is the remedy design stage. This stage is implemented after the ROD has been signed, and these treatability studies are often referred to as post-ROD treatability studies. Post-ROD treatability studies provide quantitative performance, cost, and design information (EPA, 1991). This information is then used to design the

remedial treatment process, refine the remedial action cost estimate, and make accurate predictions of the time required for remediation.

There are three technologies proposed for this remedial action which require treatability testing, solidification/stabilization, soil washing and UV oxidation. In addition, trench tests are recommended to evaluate groundwater flow. Section 4.2 provides a brief overview of the pre-ROD treatability study process. Sections 4.3 and 4.4 describe the detailed treatability procedures for source control and migration control, respectively.

4.2 GENERAL TREATABILITY STUDIES

This section will focus on those treatability studies conducted prior to the ROD. The primary goals of a pre-ROD treatability study are:

- Facilitate the alternative selection process
- To select among multiple vendors and/or processes within a given technology
- To support the detailed design and the development of specifications
- To provide information supporting a detailed cost estimate.

These studies can be conducted either in the laboratory or the field, at bench or pilot scale. For these remedial actions, the treatability studies will likely be conducted in the laboratory, by either the Army, or the various vendors interested in performing the remedial activities.

Bench-scale testing is usually conducted in the laboratory, and is best used to establish treatment parameters. Bench-scale testing is useful for established technologies, such as solidification and soil washing, since it can be used to pinpoint site-specific operating parameters. Pilot-scale testing can be done either at the site or in the laboratory. In pilot-scale testing, smaller versions of the actual treatment equipment, or the actual treatment equipment may be used. Since solidification/stabilization, soil washing, and UV oxidation are demonstrated technologies, bench-scale treatability work would be appropriate.

The first step in any treatability study is establishing the Data Quality Objectives (DQOs) and preparing the study workplans. DQOs are qualitative and quantitative statements that specify the requirements for the data collected during the study. The final DQOs will be incorporated into the treatability study design, workplan, sampling and analysis plan, and chemical data acquisition plan will ensure that the data collected are of sufficient quality to support the objectives of the treatability study. For pre-ROD treatability studies, fairly

rigorous Quality Assurance/Quality Control (QA/QC) will be required. Since the QA/QC required will be similar to that required for the remedial investigation, the chemical data acquisition plan developed in support of the RI/FS (MAIN, 1991) will be modified for use in the treatability testing.

An important part of the DQO and workplan process is identifying the treatment goals. These goals include, but are not limited to the attainment of ARARs and TBCs. The treatability study workplan will clearly delineate all treatment criteria for this remedial action.

The subsections generally included in a treatability study workplan are:

- Project description
- Remedial technology description
- Test objectives
- Experimental design and procedures
- Equipment and materials
- Sampling and analysis
- Data management
- Data analysis and interpretation
- Health and safety
- Residuals management
- Community relations
- Reports
- Schedule
- Management and staffing
- Budget

Not every one of these items will be described in detail in each workplan, but it is important to at least consider each item. Most of the section titles are self-explanatory, and will not be described in detail, but there are several points which should be highlighted. First, health and safety merits its own section in the workplan. Health and safety is very important because the soil to be treated contains potentially hazardous constituents. Not only will the party implementing the work plan be required to follow the health and safety plan, but they must be in full compliance with all Occupational Safety and Health Administration (OSHA) and EPA regulations regarding working with hazardous materials.

Once the workplan has been completed, the next step in the process is to identify the party who will implement the study. For solidification/stabilization, and soil washing the technologies used by the various vendors are similar, and the major differences between the vendors involve proprietary materials. For UV oxidation, each vendor has a slightly different technology, but the overall process is similar. Therefore, it is likely that the treatability studies will be carried out by the vendors, so that the proprietary materials can be used. It will be important to clearly specify the goals of the study so that the results of the different vendors can be accurately compared and evaluated.

Once the work plans have been finalized and the vendors have been selected, the next step will be to collect a representative sample. A sufficient volume of sample for all the studies to be conducted will be collected. A set volume of soil could be collected from each area designated for remediation in proportion to the volume of soil in the given unit. All the soil collected would be composited and apportioned to each vendor. Groundwater can be collected from the trench used for the trench test or from a representative group of wells. This assures that each vendor will be testing similar material.

Once each vendor has completed their studies, the data must be reviewed and assessed prior to contractor selection and the completion of the detailed designs and specifications. The results will be reviewed to ensure that each technology meets the specified treatment criteria. All technologies that meet the treatment criteria will then be reviewed for other items, such as cost-effectiveness and ease of implementation. Once a vendor is selected, detailed design and specifications will be developed.

4.3 SOURCE CONTROL TREATABILITY STUDIES

4.3.1 Solidification/Stabilization

The first step in preparing the DQOs and work plans for the solidification/stabilization treatability study is to determine the final disposition of the treated soils, in order to specify the treatment criteria. If the waste will be disposed of on-site, a treatment criterion is structural strength. Typically, the design bearing strength is that which is required to support construction equipment during installation of the final landfill cover. Another important treatment criterion is volume increase. A solidification/stabilization process which minimizes the volume increase of the treated soil is desirable because final disposal costs, are dependent on the volume of the material to be disposed of.

Next, as described above, a representative sample must be collected. A number of preliminary tests will be run on the soil to establish baseline conditions. These tests will include a full TCLP metals analysis, moisture content, percent solids, and density. Total metals analysis may also be run, if additional data is required.

The next step is the treatability work itself. Often, the primary admixtures used are cement, lime (or lime kiln dust), and fly ash. These are used either individually or in varying mixtures of two or three. Most vendors also use proprietary admixtures. Therefore, the admixtures to be used in this treatability study will not be specified by the Army.

The admixtures will be added to the soil in varying ratios based on the dry weight of the soil. Water will be added as necessary, and the final volume of water added will be recorded. The mixtures will then be allowed to cure. At different times in the curing process, usually at 1 day, 3 days, 1 week, 2 weeks, and 1 month, the mixtures will tested to determine if the treatment criteria are met. These tests may include TCLP metals, bearing strength, volume increase, and moisture content. The actual testing schedule and parameter list will vary, depending on the vendor and the final disposition of the treated soil. Each vendor will then prepare a final report which documents all the results of the testing. The report will demonstrate which admixtures and curing times meet the treatment criteria. The Army will then evaluate the results to determine the most cost-effective of the admixtures which meet all the treatment criteria.

The results of the treatability study will then be used to prepare the final design and specifications. It is anticipated that the design will involve performance specifications geared towards meeting the treatment criteria, as opposed to design criteria which specify he admixtures to be used and the different ratios.

4.3.2 Soil Washing Treatability Studies

The mechanics of the soil washing treatability study are very similar to those of the solidification/stabilization treatability study. Again, a DQOs and a work plan will be developed to describe the goals of the study. Representative samples will be collected. The pre-study testing will vary slightly for the soil washing treatability study. Preliminary data will include a full TCLP metals analysis to establish baseline conditions, and a number of physical chemical properties to aid in developing the treatment process. At a minimum, the soils will be analyzed for particle size distribution (sieve and hydrometer), dry bulk density, moisture content, total organic carbon, pH, and soil mineralogy.

One important test which is run for the soil washing treatability study is a chemical analysis on each of several soil fractions separated with sieves. Often, most of the chemical constituents are associated with the fine fraction in the soil. When this is the case, wet separation unit operations can significantly reduce the quantity of soil which needs to be treated. By analyzing the different fractions prior to treatment, the distribution of the potentially hazardous constituents with respect to particle size can be determined.

The first step in the treatability study is usually a series of jar tests. Soil samples are placed in a series of jars, and an equal volume of liquid is added to each jar. Usually plain water (hot and cold) are the first liquids tested. Other liquids to test include aqueous solutions of surfactants, chelating agents, or other dispersing agents. The pH of the test water may also be varied. After the liquids are placed in the jars, the jars are shaken. Next, the soil/water mixture is poured into a 2mm sieve. The water is allowed to drain, and the remaining soil is rinsed with clean water. After the soil dries, it is analyzed to determine the percent reduction. The solutions which yield satisfactory results are carried over to the next stage of the study.

The bench-scale testing is far more involved than the jar tests. The first step is often to determine the optimal wash times, washwater to soil ratios, and rinsewater to washwater ratios (EPA, 1991). Once these values are determined with plain water, the optimal additives determined in the ar testing stage can be used. Each of the other additives can be evaluated to determine the solution which best removes hazardous constituents from the coarse fraction. The wash water and rinse water will also be analyzed for mass balance purposes, and for determining the best treatment and disposal option for the washwater. If necessary, treatability testing will be conducted on the washwater.

The last step is evaluating the results of the treatability study. Analytical data taken before and after the washing are used to determine the removal efficiency. The particle size distributions can be used to estimate the volume reduction of the process. The effectiveness of the washwater treatment and fine soil separation must also be considered. These results will then be used to size the final unit, specify the reagents and reagent ratios, and prepare a detailed cost estimate for the process.

4.4 MIGRATION CONTROL TREATABILITY STUDIES

Treatability testing requirements for the migration control technologies are far less involved than for the source control alternatives.

The primary unit operations which would require treatability studies would be the UV oxidation process integral to alternative MC-6.

Treatability tests are carried out on a representative water sample, in order to confirm the preliminary capital and operating cost estimates that were based on the characterization of the subject water. They also enable optimization of the UV/Oxidation system for each particular application.

Typically, a design test constitutes a series of runs on a pilot-scale UV batch reactor, where the effect on treatment of:

- pre-treating the sample water,
- adjusting the concentration of hydrogen peroxide, ozone, and any catalyst, and
- varying the applied UV dose

is determined until the optimum set of conditions is found. The optimum choice of factors varies from one contaminated water to another, and all parameters can be adjusted to give a more effective treatment.

The details of a typical UV oxidation treatability study would involve the following tasks. Upon receipt of the sample water, the UV oxidation vendor will perform an initial water characterization test to determine if pretreatment is required. This includes testing of the major parameters which can effect the treatment of the sample water. This includes analyses for subject contaminants levels, Chemical Oxygen Demand (COD), UV absorbance, iron, chloride, carbonate/bicarbonate levels, pH and nitrate levels.

Design testing is typically performed on a 1 KW Bench unit. This unit consists of a 27 L batch tank, a recycle pump and a 1 kW reactor. The total volume of the system is 33L. The 1 kW lamp which is used has an identical UV output to the 30 kW lamps which are used in a full scale system so that scale-up using the design parameter, UV Dose, is accurate. The unit also has a transmittance controller which is activated by the operator at regular intervals to wipe the lamp to ensure that it remains clean throughout the entire run.

In each design test, 30 L of sample water will be pumped into the bench unit batch tank and will be recirculated through the UV reactor and back to the batch tank. If required, the water will be spiked with the subject contaminants to ensure that the concentration in the

design test corresponds with the expected influent concentrations in the full scale system. An initial sample of the water will be taken before any reagents are added to the batch tank.

The water will be prepared for treatment by the addition of one or more reagents (i.e., hydrogen peroxide, catalysts). If required, the pH is reduced with sulfuric acid and then any catalysts required are added and mixed.

Once all of the reagents are added and have been allowed to mix, the UV lamps will be turned on. Samples will be taken at predetermined time intervals which correspond to specific UV doses. Samples will be taken for analysis by in-house instrumentation and an independent laboratory. The pH and residual peroxide level are also monitored throughout the run.

Data from series of design tests are plotted to determine which treatment process which provides the most cost effective option for the destruction of the subject contaminants.

The requirements for the treatability testing include:

- One 55 gallon drum of the subject water. This large volume of water ensures that several tests using batches of 30 L can be performed. This allows for a more reliable scale up to a commercial system. Arrangements for delivery of these drums from the site to the vendor must be made in advance since hazardous waste regulations may apply. Normally the samples are not preserved during transport.

- All existing analytical data on the actual subject water including the expected influents of the full scale system, and

- The discharge objectives, as well as the proposed full scale flow rate.

The testing protocol which would be proposed is as follows:

Step 1. Determine the requirement for pretreatment. This determination will be based on visual examination of the water as well as the analytical data on iron and suspended solids. Water with high (> 100 ppm) concentrations of iron present are generally not a problem so pretreatment is not normally required.

Step 2. Carry out a series of four batch runs of 30 L each. The runs will be carried out in a 30 L bench unit that is equipped with a 1000 W high intensity UV lamp. The amount of UV light for each run will be determined by the length of the run. A total of six samples will be taken from each batch run, which includes an initial sample plus four treated samples plus one duplicate for QA/QC purposes. The most significant pollutants will be monitored in the laboratory using a direct injection GC/FID, ASTM method D2908-97, to determine the progress of the treatment.

Step 3. After analyzing the data from the first 5 batch runs, the best process(es) will be chosen and optimized. Samples from the optimum run will be sent to the Engineering-Science independent laboratory for analysis and confirmation.

Step 4. Upon receipt of the final analytical data, a report will be submitted providing:

- Description of the bench scale testing performed
- Presentation of the analytical results
- An assessment of the results, with recommendation of the best process for the full scale system.
- Preliminary design of a full scale system, including:

  - design of full scale system, with dimensions of equipment
  - capital cost of the system to +/-20% accuracy
  - detailed O&M cost estimates
  - delivery schedule of equipment, and
  - statement of the performance guarantee and warranty for the system

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 GENERAL

The detailed analysis of alternatives are separated into Source Control alternatives and Migration Control alternatives. As discussed in the previous sections, Source Control and Migration Control alternatives involve clear and distinct technologies for the remediation of different constituents of concern in the two media, soil and groundwater. In addition, completion of the Removal Action for the source of the groundwater plume has minimized the interaction between the soil and the groundwater media. According to the CERCLA RI/FS Guidance Manual (USEPA, 1988), if interactions between the two media are not significant, an FS may describe options by media instead of on a sitewide basis. The constituents of concern for soils include metals and PAHs and the constituents of concern for the groundwater are VOCs. Remedial Action Objectives have been developed for each media and these objectives may be achieved more effectively by evaluating and conducting the remediation alternatives independently.

Source control alternatives SC-1, SC-2, SC-3, SC-4 and SC-5 and migration control alternatives MC-2, MC-3, MC-5, and MC-6 have been retained for analysis in this section. Further definition of each alternative is presented and the same criteria used in Section 3.0 is applied to evaluate these alternatives. Cost estimate summaries are provided for each alternative. More detailed cost information is in Appendix D.

5.2 DETAILED ANALYSIS OF SOURCE CONTROL (SC) ALTERNATIVES

5.2.1 Analysis of Alternative SC-1: No Action

5.2.1.1 Definition of Alternative SC-1

The no action alternative means that no remedial activities would be undertaken at the site. No monitoring or security measures, would be undertaken other than those currently implemented at the site. Any attenuation of the threats posed by the site to human health and the environment would be the result of natural processes. Current security measures include the SEDA-wide security activities which effectively eliminate public access to the area. This is required because the Ash Landfill site is located within the area of the facility which includes the storage of munitions. Access to the this site will be limited as long as SEDA is active. If SEDA is inactive, munitions will no longer be stored. Security activities would still continue while this parcel is under Army control, and is not associated with this alternative because this is part of normal base activities.

This alternative has been retained and will be used as a baseline for comparison with all of the other source control alternatives developed as part of this feasibility study.

5.2.1.2 Protectiveness

The protectiveness of this and all alternatives are assessed with regards to short- and long-term protectiveness to both human health and the environment. The Baseline Risk Assessment (BRA) performed as part of the Remedial Investigation (RI) indicates that, in the short-term, the no action alternative is protective of human health, since the calculated carcinogenic risk for current and future intended land use is 1×10^{-4}, which is at the upper end of the EPA target risk range. The non-carcinogenic risk HI of 0.24 is less than 1.0 and is therefore considered protective of human health. Since the current SEDA security measures prevent public access to the site, there is little or no risk to the public because there is no exposure. Access by site workers is infrequent and limited to routine patrol activities. This alternative will also provide short-term protection of the environment. All ecosystems studied during the RI appeared to be normal.

The no action alternative also provides long-term protectiveness of human health and the environment. As described in the BRA portion of the RI report, the intended future long term land use of the site is as an undeveloped land parcel. This land could be occasionally used by hunters during the annual SEDA deer hunt. Under the current and intended future land use scenario, the BRA indicated that, the on-site concentrations are protective of human health in the future. However, this alternative does not protect against ingestion of and direct contact with soil having concentrations of lead above 500 mg/kg, or prevent potential leaching of lead from the soil into the groundwater above the federal action level.

5.2.1.3 Reductions

Current site conditions indicate that there are reductions in the concentrations of pollutants in the impacted soil at the site. Natural attenuation and degradation, through biological, photochemical and physical interactions between the constituents of concern and the soil/groundwater system have decreased the concentrations of pollutants in the soil. Heavy metals are environmentally stable and do not degrade and there has not been reductions of these pollutants. However, heavy metals do not appreciably contribute to the risk.

5.2.1.4 Permanence

The no action alternative does not provide a permanent solution since no treatment will occur.

5.2.1.5 Compliance with ARARs

There are no promulgated soil standards to use as ARARs for comparison with on-site soil concentrations and therefore this alternative complies with the chemical- and location-specific ARARs specified in Appendix C. There are no action-specific ARARs.

5.2.1.6 Implementability

The criterion of implementability is not applicable to the no action alternative since there are no activities occurring. There would still be security activities, as described above, as well as some administrative requirements but these activities are performed as part of the existing security program because this is an active military installation. These peripheral activities are already occurring and will continue until the intended use of the site changes.

5.2.1.7 Cost

There are no costs associated with the no action alternative. The costs associated with the monitoring and security described above are covered through other mechanisms, and are not directly attributable to this remedial action.

5.2.2 Analysis of Alternative SC-2: Excavation of Both Landfills/Disposal in an Off-Site Subtitle D Landfill

5.2.2.1 Definition of Alternative SC-2

This option consists of excavation of either all or portions of the Ash Landfill, the debris piles, and the Non-Combustible Fill Landfill (NCFL). The results of the RI indicate that these areas are well defined localized areas that are less than 10 feet deep, and could be removed with standard construction equipment. The excavated materials would then be transported to an off-site, Subtitle D, solid waste, industrial landfill. A Subtitle D landfill refers to a solid waste landfill that meets the NYSDEC and USEPA Subtitle D landfill construction specifications.

The first step in this option, as with most of the other options is excavation. An excavation plan will be developed using previous RI data to delineate the extent of removal. The data indicates that the soils to be removed are limited to the areas described above, although the excavation depths will vary. Three cases are considered for excavation, the volumes and areas to be

excavated are described in Table 2-7 of Section 2.0. The maximum volume to be excavated is approximately 45,500 cubic yards, which is all the soils except the soils in the "Bend-in-the-Road", which were part of the Removal Action. The excavation will be accomplished with standard construction equipment, such as a front end loader or bulldozer.

The final step in this alternative is disposal of the excavated materials. These materials will be considered a solid waste subject to RCRA Subtitle D and New York State solid waste regulations. In New York, all sanitary landfills are authorized to accept industrial wastes, and therefore would be able to accept the materials excavated from the site. These landfills cannot accept hazardous waste, and therefore require extensive testing to assure that the waste is not a hazardous waste. The actual testing requirements vary from landfill to landfill, and the exact requirements for this remedial action will be specified once a landfill is selected.

Two landfills which may be used for this remedial action have been identified. The first is the Seneca Meadows landfill located in Waterloo, New York, approximately 10 to 15 miles from the site. The other landfill is the Waste Management of New York High Acres landfill in Fairport, Monroe County, approximately 40 to 50 miles from the site.

A detailed analysis of how this option meets the selection criteria and a budgetary cost estimate are also provided below.

Process Flow and Site Layout

The process for this alternative consists of two steps. First, the soil is excavated, as described above. The soil is then placed in trucks and hauled to the appropriate landfill.

There is no need to devise a site layout for this alternative. The site is almost completely accessible by trucks, and each truck will be loaded directly from the excavation. A small staging and equipment decontamination area will be set up as necessary, and will likely be located near one of the site roads.

5.2.2.2 Protectiveness

The short- and long-term protectiveness to both human health and the environment have been considered. The following discussion will show how this alternative meets these criteria.

Short-term Protectiveness

Several items are included in an assessment of the short-term protectiveness of Alternative SC-2. The first issue is protection of the community during the remedial action. Excavation will be the only process performed on site, however, there will be the need to transport the materials to an off-site landfill. The increase in truck traffic will increase the potential for off-site accidents and will be considered during the planning of the remedial action. This is not considered to be a significant issue since the area surrounding SEDA is agricultural with spare residences. Care will be taken to assure that the trucks are not overloaded. The soils will be covered with a tarp during transport to ensure that no dust is released from the trucks.

The threat from dust released during the on-site excavation will be eliminated through the use of dust suppression techniques. A monitoring program will be established around the perimeter of the excavation area in order to assure protection of the community. The closest area to be excavated from the SEDA boundary, is approximately 750 feet, so the likelihood of any dust migrating offsite is negligible. As discussed in Section 5.0 of the RI report, fugitive dust migration is not considered to be a major migration pathway.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during excavation are direct contact with the affected soil and inhalation of particulates. Protection from exposure can be maximized through site access controls and the use of proper protective equipment for site workers, such as dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. For this alternative, there will be little or no environmental impacts. This alternative calls for construction type activities in an area of the Depot where trucks and trains routinely load and unload munitions. These activities will not be substantially different from what is currently occurring. In addition, since the hazardous material is primarily in the soil, there is little or no risk of a spill or release of liquid hazardous materials during the remedial action.

The last item to be considered, is the time until treatment is accomplished. Alternative SC-2 should be completed in a brief period of time. This is a "dig and haul" operation, and would only take one to two months, depending on the weather. There is little mobilization, since only a loader, and maybe a scraper are necessary to accomplish the excavation. It should only take one to two days to set up the staging area and construct an equipment decontamination pad. Once the soil is removed, the remedial action would be complete.

Long-term Protectiveness

The assessment of the long-term protectiveness of Alternative SC-2 can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the controls used for the waste residuals and untreated soil.

The magnitude of the residual risk has been quantified during the baseline risk assessment and from considering the effects of remediating various areas of the site. The soils currently demonstrate a hazard quotient less than the EPA target value of 1 for the noncarcinogenic risk and from the standpoint of non-carcinogenic risk, there is no need to do anything. If implemented, and the risks are controlled as described for Case 4 in Table 2-9, the carcinogenic risk will be reduced to 2.8×10^{-5}, which is lower than the EPA target value of $1.0 \text{ X } 10^{-4}$ and, therefore, this alternative will be protective of human health. The reduction in risk produced by implementing this alternative is not that different from the benefits obtained by implementing only the non-time critical removal action. This alternative also protects against ingestion of and direct contact with soils having concentrations of lead above 500 mg/kg, and prevents potential leaching of lead into the groundwater by removing soil with concentrations of lead above 500 mg/kg.

The controls to be used for long-term management are also easy to assess. No residuals will remain on site. The long-term management will be left to the TSD facility selected for receiving the soil. It will be important to select a well run TSD facility in order to ensure that the soil is properly handled and disposed of.

As described above, there will be no long-term maintenance required at the site. Any exposed areas will be regraded to minimize erosion potential. Any areas in which soil was removed below grade will be backfilled with clean soil. A cover of native vegetation will be established as an additional erosion control measure, but once the cover is established, maintenance activities will no longer be required.

5.2.2.3 Reductions

Overall, this alternative would be very effective in reducing the mobility of the constituents present in the soils at the site. The soil will be landfilled which will reduce the mobility of hazardous constituents and prevent dermal contact to human and environmental receptors. Since these soils will be removed from the site, the toxicity and mobility of the hazardous constituents at the site will no longer be an issue.

5.2.2.4 Permanence

The permanence of the alternative has also been assessed. Once the soil is removed from the site, the remedial action would be essentially permanent, providing that adequate maintenance procedures are followed.

5.2.2.5 Compliance with ARARs

Alternative SC-2 will comply with all ARARs. A list of ARARs for this alternative is in Appendix C.

5.2.2.6 Implementability

A discussion of implementability can be divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

Technical Feasibility

The technical feasibility of Alternative SC-2 is very good. The excavation equipment used is all standard construction equipment, the process can be operated in almost all weather conditions. The excavation process is also well defined. The areas demonstrating elevated concentrations of semi-volatiles and metals have been delineated, and it will be straightforward to develop an excavation plan that assures all of the spots are removed. It is possible that some minor weather delays may be encountered, but most of the soil to be removed is located at shallow depths, and should not be adversely affected by wet conditions.

The TSD facilities in the region have accepted similar wastes for a number of years. These facilities are fully capable of treating and disposing of the Ash Landfill soils.

Another aspect of technical feasibility is the ease with which additional work may be conducted. At this time, it is anticipated that this remedial action will preclude the necessity of any additional remedial efforts at the Ash Landfill. However, if additional work is required in the future, this remedial action will not interfere in any way. Once the remedial action is complete, the site will be revegetated, and will essentially remain as it is now.

Administrative Feasibility

The administrative feasibility of this alternative is also very good. Construction permits necessary for the activities are readily attainable. The TSDFs which will be used are fully permitted. Coordination with the various regulatory agencies is also important. The Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

Availability of Services and Materials

The first item to consider is the availability of Subtitle D landfills which could accept the soils from this site. Both the Seneca Meadows and the High Acres landfills indicated that they had sufficient capacity to accept the waste, and would be willing to accept the waste if the proper analytical results were provided.

The excavation and hauling equipment is readily available. The equipment to be used is fairly standard, and is available from a number of vendors.

5.2.2.7 Cost

Capital Costs

There are two major cost items for this alternative, excavation and off-site disposal. The total capital cost is estimated to be $17,500,000. The breakdown for these costs are provided in Appendix D.

O & M Costs

There will be little or no O & M costs associated with Alternative SC-2. Once the remedial action is completed, there will be no residuals remaining on site which require management. Initially, there will be some minor costs associated with the establishment of the vegetative cover, but the cost estimate for these items have been included in the capital costs. As with the no action alternative (SC-1), the costs for SEDA security and quarterly monitoring are included in other programs, and are not part of this remedial action.

Present Worth Costs

The present worth costs for Alternative SC-2 are estimated to be $17.5 million, which are comprised of capital costs.

5.2.3 Analysis of Alternative SC-3: Excavation of the Ash Landfill and Debris Piles/Consolidation at the NCFL/Cap the NCFL

5.2.3.1 Definition of Alternative SC-3

This option consists of excavation of the soils in the Ash Landfill area, the soils at the "Bend-in-the-Road" area and the debris piles, and consolidation in the NCFL. The NCFL is an ideal area to consolidate the waste material on the site because it is currently a landfill and is located adjacent to the other areas. The residue materials from the non-time critical removal action were used as replacement fill material. Because the soils at the "Bend-in-the-Road" have been remediated, no volatile organic contaminated source soils exist at the site, and the most likely exposure pathway is, therefore, from dermal contact or ingestion of soils. Isolating these materials in the NCFL will reduce the potential for these exposures. The final cap will consist of an impermeable barrier such as clay or a geomembrane, covered with a vegetative layer. Each of these processes are described in this section. A detailed analysis of how this option meets the selection criteria, and a budgetary cost estimate are provided below.

The first step in this option, as with most of the other options is excavation. An excavation plan will be developed using previous RI data to delineate the extent of removal. The data indicates that the soils to be removed are limited to the areas described above, although the excavation depths will vary. Three cases are considered for excavation, the volumes and areas to be excavated are described in Table 2-7 of Section 2.0. The maximum volume to be excavated is approximately 32,400 cubic yards, which is all the soils listed in Table 2-7 except the soils in the

NCFL. The soils at the NCFL would remain in-place and be capped. The excavation would be accomplished with standard construction equipment, such as a front end loader or bulldozer. The excavated soil would be immediately transported to the NCFL where it will be consolidated and eventually capped.

Process Flow and Site Layout

The process for this alternative consists of two steps. First, the soil is excavated, placed in trucks and transported to the NCFL. The site is accessible by trucks, and each truck will be loaded directly from the excavation. A small staging and equipment decontamination area will be set up as necessary, and will likely be located near one of the site roads. To assure that health and safety requirements are met, air monitoring stations will also be required to monitor the emissions, both volatiles and particulates, during excavation and loading activities. Soil staging areas will be required during the construction of the cap.

5.2.3.2 Protectiveness

The short- and long-term protectiveness to both human health and the environment have been considered. The following discussion will show how this alternative meets these criteria.

Short-term Protectiveness

Several items are included in an assessment of the short-term protectiveness of alternative SC-3. The first issue is protection of the community during the remedial action. Excavation and spreading of soils during the cap construction will be the only process performed on site, however, there will be the need to transport cap materials. The increase in truck traffic will increase the potential for off-site accidents and will be considered during the planning of the remedial action. This is not considered to be a significant issue since the area surrounding SEDA is agricultural with spare residences. Care will be taken to assure that the trucks are not overloaded. The soils will be covered with a tarp during transport to ensure that no dust is released from the trucks.

The threat from dust released during the on-site excavation will be eliminated through the use of dust suppression techniques. A monitoring program will be established around the perimeter of the excavation area in order to assure protection of the community. The closest area to be

excavated from the SEDA boundary, is approximately 750 feet, so the likelihood of any dust migrating offsite is negligible. As discussed in Section 5.0 of the RI report, fugitive dust migration is not considered to be a major migration pathway.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during excavation are direct contact with the affected soil and inhalation of particulates. Protection from exposure can be maximized through site access controls and the use of proper protective equipment for site workers, such as dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. For this alternative, there will be little or no environmental impacts. This alternative calls for construction type activities in an area of the Depot where trucks and trains routinely load and unload munitions. These activities will not be substantially different from what is currently occurring. In addition, since the hazardous material is primarily in the soil, there is little or no risk of a spill or release of liquid hazardous materials during the remedial action.

The last item to be considered, is the time until treatment is accomplished. Alternative SC-3 should be completed in a brief period of time. The estimate for performing this task is approximately one to two months, depending on the weather. There is little mobilization, since only a loader, and maybe a scraper are necessary to accomplish the excavation. It should only take a week to set up the staging area and construct an equipment decontamination pad. Once the soil is removed and the cap constructed, the remedial action would be complete.

Long-term Protectiveness

The long-term protectiveness of this alternative is related to the reliability of the maintenance of the landfill area. Through routine maintenance of the cap and periodic monitoring of the landfill, this alternative can provide long term protection.

The magnitude of the residual risk has been quantified during the baseline risk assessment and from considering the effects of remediating various areas of the site. The soils currently demonstrate a hazard quotient less than the EPA target value of 1 for the noncarcinogenic risk

and from the standpoint of non-carcinogenic risk, there is no need to do anything. If implemented, and the risks are controlled as described for Case 3 in Table 2-9, the carcinogenic risk will be reduced to 2.8×10^{-5}, which is lower than the EPA target value of 1.0×10^{-4} and, therefore, this alternative will be protective of human health. The reduction in risk produced by implementing this alternative is not that different from the benefits obtained by implementing only the non-time critical removal action, which in and of itself, created a condition which is protective of human health. This alternative also protects against ingestion of and direct contact with soils having concentrations of lead above 500 mg/kg, and prevents potential leaching of lead into the groundwater by removing soil with concentrations of lead above 500 mg/kg.

As described above, long-term maintenance will likely be required at the site to assure continued protectiveness. Any exposed or eroded areas will be regraded to minimize erosion potential. Any areas in which soil was removed below grade will be backfilled with clean soil. A cover of native vegetation and an impermeable material will be established as an additional erosion control measure.

5.2.3.3 Reductions

Overall, this alternative would be very effective in reducing the mobility of the constituents present in the soils at the site. The soil will be isolated under the cap which will reduce the mobility from dissolution into groundwater or erosion and will prevent dermal contact to human and environmental receptors.

5.2.3.4 Permanence

The permanence of the alternative has also been assessed. Once the soil is consolidated and isolated under the cap, the remedial action would be considered permanent, providing that the cap integrity is maintained. The soil on the site currently does not poses an unacceptable threat to human health and the environment although implementing this alternative will provide additional safeguards from potential exposure routes.

5.2.3.5 Compliance with ARARs

Alternative SC-3 will comply with all ARARs. A list of ARARs for this alternative is in Appendix C.

5.2.3.6 Implementability

A discussion of implementability can be divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

Technical Feasibility

The technical feasibility of Alternative SC-3 is very good. The excavation equipment used is all standard construction equipment, the process can be operated in almost all weather conditions. The excavation process is also well defined. The areas demonstrating elevated concentrations of semi-volatiles and metals have been delineated, and it will be straightforward to develop an excavation plan that assures all of the spots are removed. It is possible that some minor weather delays may be encountered, but most of the soil to be removed is located at shallow depths, and should not be adversely affected by wet conditions.

Another aspect of technical feasibility is the ease with which additional work may be conducted. At this time, it is anticipated that this remedial action will preclude the necessity of any additional remedial efforts at the Ash Landfill. However, if additional work is required in the future, this remedial action will not interfere in any way. Once the remedial action is complete, the site will be revegetated, and will essentially remain as it is now.

Administrative Feasibility

The administrative feasibility of this alternative is also very good. Construction permits necessary for the activities are readily attainable. There will be some transport of clean fill and capping materials. All the contractors used for excavation and hauling will be experienced in excavating waste materials and constructing landfill caps.

Coordination with the various regulatory agencies is also important. The Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

Availability of Services and Materials

The first item to consider is the availability of capping materials. Impermeable materials are available locally. The excavation and hauling equipment is readily available. The equipment to be used is fairly standard, and is available from a number of vendors.

5.2.3.7 Cost

Capital Costs

There are two major cost items for this alternative, excavation and cap construction. The total capital cost is estimated to be $1,370,000. The breakdown for these costs are provided in Appendix D.

O & M Costs

The present worth O & M costs associated with Alternative SC-3 are approximately $490,000. Initially, there will be some minor costs associated with the establishment of the vegetative cover, but the cost estimate for these items have been included in the capital costs. As with the no action alternative (SC-1), the costs for SEDA security are included in other programs, and are not part of this remedial action.

Present Worth Costs

The present worth costs for Alternative SC-3 are estimated to be $1.86 million, which are comprised of capital costs and the present worth O&M costs, which were estimated for 30 years at an interest rate of 10%.

5.2.4 Analysis of Alternative SC-4: Excavation/Soil Washing/Backfill Coarse Fraction/Solidify Fine Fraction Cap

5.2.4.1 Definition of Alternative SC-4

This option includes five unit operations: excavation, soil washing, solidification of the fine fraction, capping and backfilling of the coarse fraction. Each of these processes will be described briefly in this section. A detailed analysis of how this option meets the selection criteria, and a budgetary cost estimate are provided below. The total volume of material to be processed is the

cumulative total of all the soil shown on Table 2-7 for. The volume to be processed for this alternative is approximately 68,700 yd^3.

The first step in this option, as with most of the other options is excavation. An excavation plan will be developed using the data from the RI to delineate the extent of the affected areas. The excavation will be accomplished with standard construction equipment, such as a backhoe or bulldozer. The areas to be removed are shallow, generally only extending 2 to 4 feet below grade. The excavated soil will then be stockpiled temporarily near the soil washing unit.

The next unit operation is the soil washing process. The primary purpose of soil washing is volume reduction. The hazardous constituents present in the soil are concentrated, generally in the fine fraction. The fine fraction is then subjected to additional treatment. In this case, the fine fraction would be solidified. The coarse fraction, which no longer contains excessive levels of the hazardous constituents, is no longer a concern, and can be backfilled on site. It is expected that the fine fraction will make up 30 percent of the overall volume.

The next step in the process is the treatment step, solidification/stabilization. Solidification/stabilization is a process in which a setting agent is added to the soil to form a mixture which entraps the metals. Solidification is primarily used to describe the physical processes, and stabilization generally refers to the chemical processes. The different setting agents used are described below. As described previously, the primary goals of solidification are to:

- Improve the handling and physical characteristics of the waste
- Decrease the solubility and mobility of the contaminants in the soil
- Decrease the surface area across which the migration of contaminants may occur.

Solidification/stabilization is a process in which the contaminants are converted to less toxic, mobile, and/or in soluble forms. The physical properties of the soil or waste are not necessarily changed by this process (EPA 1990).

Solidification/stabilization has been used primarily for the treatment of soils containing inorganic contaminants and has been shown to be effective for heavy metals. If organics are present in large concentrations, i.e., oily wastes, the setting process may be adversely affected, and may not bound up in the finished product. There are PAHs in the soils to be stabilized at the Ash Landfill but not in concentrations which are expected to cause problems, therefore, interference by organics is not considered to be a problem. Bench scale treatability tests will be conducted to assess the adequacy of a given additive to a specific soil-waste mixture.

Four types of mixtures are generally used for solidification/stabilization. Inorganic solidification/stabilization is often achieved with cement or pozzolanic additives. Organic solidification/stabilization is often accomplished with thermo-plastic or organic polymerization additives (EPA, 1989). A combination of these processes may be used for a soil containing both organic and inorganic contaminants.

In cement-based solidification/stabilization, the soil is mixed with Portland cement. Water is added to the mixture. Inorganic materials then become bound up in the cement matrix. Pozzolanic solidification/stabilization involves mixing the waste with a siliceous material, such as fly ash, pumice, or lime kiln dust. The mixture is often combined with lime or cement and water to form a cement-like final product. The end result of inorganic solidification/stabilization can be a granular material or a cohesive solid (EPA, 1989). Cement-based stabilization is the likely choice for the Ash Landfill. The landfill and debris piles are constructed primarily of fill material, much of which consists of ash and soil. The large debris items will need to be removed prior to solidification and washed, most likely with high pressure steam. The washed debris will be landfilled on or off-site at a non-hazardous waste landfill. The remaining material will be readily bound up in a cement base, and will act like the aggregate used in making concrete. Treatability testing will be conducted to determine the quantities and types of admixtures which best satisfy the treatment criteria for this site.

Solidification/stabilization can be conducted either in-situ or in a batch mode. For in-situ solidification/stabilization, the mixtures are injected into the soil and then mixed. In batch operations, the material is removed from the ground with standard earthmoving equipment and mixed in units such as standard cement trucks. The solidified material is then replaced in the ground. Batch processes require more area than in situ processes because space is necessary to store the untreated soil when it is removed from the ground. At the Ash Landfill, a batch operation will be used. The contaminated soil is shallow, and is easily removed. In addition, there is plenty of space available to set up a stockpile area and cement plant. The treated soil could be placed directly into trucks for removal to the offsite landfill. This solidified mass will then be backfilled on the site and covered with a topsoil cap to prevent erosion of the solidified materials.

Process Flow and Site Layout

The process flow schematic for this alternative is shown in Figure 5-1. A typical detailed process flow schematic for soil washing is shown in Figure 5-2. A soil washing operation would consist of several or all of the following processes:

- Vibratory screen - This unit separates the feed, and removes oversized (greater than 2-inch diameter) particles.
- Feeder module and conveyor - This unit carries and weighs material fed to the soil washer.
- Trommel screen - This unit breaks up clumped feed materials.
- Attrition scrubber - This unit adds the washwater to the broken up soil. The washwater mobilizes the fine fraction of the soil.
- Hydrocyclone separators - This unit is a solids/liquid flash separation device which separates the coarse (sand and gravel) soil from the fine (silt and clay) soil.
- Dense media separation column - This unit separates materials based on density, and would be used to separate elemental metals and other debris from the soil to be treated.
- Dewatering screen - This unit removes the fine material from the process train. The coarse fraction is rinsed, and removed from the soil washer.
- Washwater treatment system - The spent washwater is treated for reuse or disposal. The type of treatment used is site-specific.
- Plate and Frame press - This unit dewaters the fine fraction prior to solidification.

The stockpiled soil would be loaded into the soil washing unit with a front-end loader. The conveyor would be equipped with a scale to keep track of the quantity of soil treated. For this site, a 25-ton per hour (tph) unit would be used. This unit is delivered on fifteen 45-foot trailers. The total size of the soil washing operation is approximately 100 feet by 200 feet. The assembled unit

TABLE 2-1 (cont)

EXPOSURE POINT CONCENTRATIONS - CHEMICALS OF CONCERN FARMHOUSE WELLS QUARTERLY MONITORING RESULTS VALIDATED ON-SITE DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC AWQS*	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration
Volatile Organics						
Vinyl chloride	ug/L	2	0.25	0.25	0.25	0.25
1,2-Dichloroethene (total)	ug/L	5	0.25	0.25	0.25	0.25
1,1,1-Trichloroethane	ug/L	5	0.25	0.25	0.25	0.25
Trichloroethene	ug/L	5	0.25	0.25	0.25	0.25
Semi-volatiles						
2-Methylnaphthalene	ug/L	NA	NA	NA	NA	NA
Metals						
Aluminum	ug/L	NA	324	36413.76	112.14	324.00
Cadmium	ug/L	10	1.55	1.48	1.34	1.48
Chromium	ug/L	50	1.65	1.65	1.39	1.65
Copper	ug/L	200	1.05	1.04	0.98	1.04
Lead	ug/L	25	4	2.61	1.54	2.61
Nickel	ug/L	NA	4.15	4.16	3.19	4.15
Zinc	ug/L	300	501	523.58	302.27	501.00

* NYSDEC AWQS for Class GA waters. From 6 NYCRR Subparts 701-705

	Federal MCLs (ug/L):	
Vinyl Chloride	2	
1,2-Dichloroethene	(cis) = 70; (trans) = 100	
1,1,1-Trichloroethane	200	
Trichloroethene	5	
2-Methylnaphthalene	NA	
Aluminum	NA	
Cadmium	5	
Chromium (total)	100	
Copper	1,300	(action level)
Lead	15	(action level)
Nickel	100	(being remanded))

TABLE 2-1 (cont.)

EXPOSURE POINT CONCENTRATIONS - CHEMICALS OF CONCERN
SEDIMENT ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC CRITERIA*	MAXIMUM	95 th UCL of the mean	MEAN	Exposure Point Concentration
Semivolatiles						
2-Methylnaphthalene	ug/kg	NA	30.00	30.00	30.00	30.00
Acenaphthylene	ug/kg	NA	170.00	151.82	95.00	151.82
Phenanthrene	ug/kg	1,390	1,200.00	499.46	379.78	499.46
Benzo(a)anthracene	ug/kg	130	4,900.00	1,696.30	698.44	1,696.30
Benzo(b)fluoranthene	ug/kg	130	4,500.00	1,609.62	692.56	1,609.62
Benzo(k)fluoranthene	ug/kg	130	3,700.00	1,424.29	602.78	1,424.29
Benzo(a)pyrene	ug/kg	130	3,900.00	1,658.39	621.35	1,658.39
Indeno(1,2,3-cd)pyrene	ug/kg	130	2,400.00	1,263.37	513.83	1,263.37
Dibenz(a,h)anthracene	ug/kg	NA	1,300.00	537.25	423.61	537.25
Benzo(g,h,i)perylene	ug/kg	NA	2,300.00	971.19	508.72	971.19
Metals						
Aluminum	mg/kg	NA	20,900.00	15,013.53	13,763.33	15,013.53
Antimony	mg/kg	NA	10.80	6.51	5.54	6.51
Arsenic	mg/kg	5	12.10	7.40	6.23	7.40
Barium	mg/kg	NA	227.00	123.30	105.96	123.30
Beryllium	mg/kg	NA	1.20	0.89	0.79	0.89
Cadmium	mg/kg	0.8	4.10	2.49	1.92	2.49
Chromium VI	mg/kg	26	33.40	24.62	22.83	24.62
Cobalt	mg/kg	NA	17.00	11.19	10.09	11.19
Copper	mg/kg	19	58.60	39.69	34.59	39.69
Lead	mg/kg	27	219.00	95.63	70.48	95.63
Manganese	mg/kg	428	1,050.00	675.43	562.94	675.43
Nickel	mg/kg	22	45.90	32.05	29.41	32.05
Thallium	mg/kg	NA	0.52	0.50	0.33	0.50
Vanadium	mg/kg	NA	30.70	23.86	21.94	23.86
Zinc	mg/kg	85	834.00	455.05	365.39	455.05

* NYSDEC sediment criteria, December, 1989

TABLE 2-1 (cont.)

EXPOSURE POINT CONCENTRATIONS - CHEMICALS OF CONCERN
SURFACE WATER ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC AWQS*	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration
Volatile Organics						
Chloroform	ug/L	NA	2.00	2.00	2.00	2.00
Metals						
Aluminum	ug/L	NA	2,410.00	96,163.98	818.34	2,410.00
Antimony	ug/L	NA	141.00	74.34	43.56	74.34
Arsenic	ug/L	360	2.90	2.23	1.86	2.23
Beryllium	ug/L	NA	1.20	0.81	0.56	0.81
Chromium	ug/L	NA	7.60	5.64	4.05	5.64
Cobalt	ug/L	110	6.90	8.87	4.70	6.90
Copper	ug/L	65.4	21.70	15.86	11.04	15.86
Lead	ug/L	477.8	42.30	3,485.81	8.08	42.30
Manganese	ug/L	NA	941.00	636.3	328.59	636.31
Nickel	ug/L	5,289.7	11.20	15.4	6.48	11.20
Zinc	ug/L	1,015.3	187.00	2,235.23	59.85	187.00

* NYSDEC AWQS for Class D surface waters. From 6 NYCRR Subparts 701 - 705.

Although the outcome of the risk evaluation did not suggest that a remedial action is required for soil, it was recognized that lead was not part of the risk analysis and should be considered. Lead was not considered as part of the risk assessment because EPA has withdrawn the allowable Reference Dose (RfD) values for lead. However, since NYSDEC has promulgated standards for protection of groundwater, it was determined for soils the allowable lead concentrations in soil should be related to the NYSDEC GA classification, which is 25 ug/L. The EPA performed a modeling study during the FS process for the OB Grounds at SEDA in April 1995 and proposed an allowable concentration of lead in soil that will not produce a concentration of lead in groundwater above the federal action level for lead of 15 ug/L. The leaching model, VLEACH, was used to estimate a general range of leaching concentrations for lead and considered mixing of the leachate at the groundwater interface. The results were provided as a range of allowable soil concentrations. The range of simulated soil clean-up values for lead in soil was determined to be 16 mg/kg, 88 mg/kg, and 483 mg/kg. Since the background concentration of lead in soil was determined to be approximately 30 mg/kg, the lower value was discounted. The simulated soil clean-up values were determined to be greatly influenced by soil sorption characteristics and there is some uncertainty with the values presented, however, this effort is useful in providing a range of soil concentrations that would be considered protective of groundwater.

In addition, Parsons ES performed modeling for soil as part of the FS for the OB Grounds using the EPA model, Biokinetic Uptake Model for Lead in Children (UBK). This model evaluates the impacts of children, in a residential setting ingesting lead from various sources, including soil The results of this model suggested the range of allowable lead in soil would be approximately 500 mg/kg to 1000 mg/kg. This UBK model was considered as a factor in establishing a soil clean-up value for lead in soil because the depot has been listed as a facility to be closed under the BRAC95 program.

The site-specific clean-up goal for lead in soil and on-site sediment at the OB Grounds was established at 500 mg/kg. This concentration was adopted for the Ash Landfill although the future intended use of the site may differ from that of the OB Grounds.

Although the 95th UCL of the mean for metals in the groundwater from the Ash Landfill exceed the associated Federal MCLs or NY State Class GA standards, turbidity is likely the cause of the exceedences of metals standards in groundwater. In order to demonstrate that turbidity is the cause of these exceedences, high turbidity samples were compared to low turbidity samples and are presented in Table B of Appendix H. Turbidity data for many of the groundwater samples

collected in January 1992 (which were not previously included on Table 2-7 of the Ash RI) has been included in the current metals data set. Table B presents all of the available turbidity and metals data for each well at the Ash Landfill. For each well, the sample with the highest turbidity was compared to the sample with the lowest turbidity and the percent reduction in the metals concentration when the high and low turbidity samples were compared is shown in the far right hand column of Table B.

The analysis indicates that the metals concentrations are significantly reduced in the low turbidity samples, often below the MCL or GA standards. However, in some instances the turbidity in the least turbid sample was still relatively high and the concentration still exceeded the standard; the metals that exceed MCL or GA standards are highlighted in Table B. In all, metals concentrations in 10 wells exceed their respective MCL or GA standards. The metals that exceeded their standards in the 10 wells are as shown in collapsed form on Table A of Appendix H. The metals iron, manganese, and sodium were not included in this tally of 10 wells because these metals are very common (i.e., naturally occurring) in soil and groundwater and, more importantly, they are generally considered to be significantly less toxic than many of the other metals. Thus, exceedences by these metals are not believed to justify their consideration in remedial alternatives for groundwater, especially when turbidity is believed to be the cause of these and other exceedences at the site.

This discussion focuses on the more toxic metals cited in the Table A. For many of these metals, the concentration is significantly reduced from the higher turbidity sample to the lower turbidity sample, and often the concentration was reduced to below the standard (e.g., PT-18, PT-19, MW-28, MW-31, and MW-32) (Table B). For many of the latter wells in Table A, only one sample was available so no turbidity comparison could be made, however, the turbidities in the samples from these wells were relatively high (MW-43 through MW58D).

Lead exceeded the standards in 8 wells (Table A of Appendix H). Lead exceedences generally ranged from 17.3 µg/L to 28.8 µg/L, which is only slightly above the MCL and NYS Class GA standard values of 15 µg/L and 25 µg/L, respectively. Also, the sample from MW-56 contained a concentration of 44 µg/L and a turbidity of 18,000 NTUs. Considering the relatively high turbidity in these samples, and the relationship between turbidity and lead concentration demonstrated from other on-site samples, less turbid samples from these wells would likely have lower concentrations of lead. Because these concentrations are already only slightly above the standards, low turbidity samples would in all likelihood be below the MCL and Class GA

standards. At MW-44, the lead concentrations was 147 µg/L (NTU = 100), which is the highest exceedence at the site. Currently, the lead concentration in groundwater at MW-44 is believed to be significantly lower since the removal action was performed and approximately 921,136 gallons of groundwater was removed from this area of the site.

Chromium exceeded the standards in 7 wells as shown in Table A. Chromium exceedences generally ranged from 59 µg/L to 88.4 µg/L in 6 of the samples, and they are below the Federal MCL of 100 µg/L but above the NYS Class GA standard of 50 µg/L. One sample from MW-56 contained a chromium concentration of 351µg/L, but this concentration was associated with an extremely high turbidity value (18,000 NTUs). Again, all of these exceedences are related to high turbidity samples, and less turbid samples would result in lower chromium values, presumably below the Class GA standard.

Nickel exceeded the standards in 6 wells as shown in Table A. Nickel exceedences generally ranged from 101 µg/L to 122 µg/L, only slightly above the Federal MCL of 100. The highest nickel concentration (533 µg/L) was associated with a turbidity value of 18,000 NTUs in MW-56. Again, less turbid samples would likely result in nickel concentrations below the MCL standard.

The remaining metals (zinc, antimony, barium, beryllium, and copper) exceeded their standards in one to three wells, and like the metals cited above, their exceedences are believed to be caused by the high turbidities in the samples (Table A).

Lastly, the filtered samples demonstrate that at even lower turbidities, the metals concentrations in these samples are reduced such that only one exceedence occurred; antimony was found in PT-26 at a concentration of 53.1 µg/L. It is noteworthy that PT-26 is located approximately 2,500 feet southwest of the Ash Landfill and is not in close proximity to any of the other wells on-site, yet exceedences for chromium, lead, nickel, and antimony were measured in this well. The high turbidity in this well is likely responsible for the many of the exceedences.

On the basis of the data presented in the attached tables, metals are not believed to be a constituent of concern in the groundwater at the site and, therefore, metals in groundwater are not considered in the development of remedial actions.

In addition, the ecological risk assessment has identified instances where specific data points exceed the NYSDEC Sediment Criteria for selected metals. Unlike the human health risk

assessment, the ecological risk assessment does not calculate a quantitative total site risk value; rather ecological risks are determined by a comparison of established NYSDEC criteria and literature values that are considered to be protective of the ecological community. In all instances of risk calculation and ARAR/TBC comparison, the 95th UCL or maximum detected concentration, whichever is lower, is used as either the value of comparison or the exposure dose for calculation of the risk (i.e., the Exposure Point Concentration [EPC]).

Based upon the results of the baseline risk assessment there are no unacceptable risk levels and there is no need to perform a remedial action. The principal media of interest at the Ash Landfill is soils, since the leaching models suggest that lead could adversely leach from soils at the site and soils contribute the most to the total carcinogenic and non-carcinogenic risks. These risks are the sum of all non-carcinogenic and carcinogenic risks for both current and future site use scenarios. The risks do not exceed the EPA target range for carcinogenic risks of 1×10^{-4} to 1×10^{-6} nor do they exceed the non-carcinogenic risk level of 1.0. The greatest contributor to risk was as a result of the inhalation of volatile organics from soils, which is an exposure pathway for current on-site hunters and future on-site construction workers. Carcinogenic and non-carcinogenic risks from groundwater exposure pathways only apply to current off-site residents since no on-site drinking water wells exist or are planned for the future; therefore these risks are all below EPA risk criteria.

In summary, the baseline risk assessment and leaching models demonstrate that the principal media of interest for the development of remedial action alternatives for the former Ash Landfill are soils.

2.2.3 Risk-Based Remedial Action Objectives

The primary threat at the SEDA Ash Landfill is through exposure to contaminated soils. As shown in the baseline risk assessment conducted as part of the RI, volatile organics in groundwater do not pose a threat to human health because ingestion of on-site groundwater is not an exposure pathway under current or intended future land uses. The risks posed by other contaminants (i.e, metals, SVOC) fall within or below the EPA target ranges. TCE and its breakdown products are present in the groundwater plume which has migrated off-site, although no concentrations above ARARs have been measured. The presence of TCE, DCE and vinyl chloride in the soil does not pose an unacceptable threat of airborne exposure through volatilization because the non-time critical removal action has remediated the soils that were the source of these VOCs. Finally, the impacted soil does not pose an unacceptable threat through occasional soil exposure to existing SEDA personnel.

The risk-based remedial objectives are to reduce any non-carcinogenic and carcinogenic risks to acceptable levels based upon EPA criteria established under CERCLA and SARA. Since current and intended future risk scenarios do not exceed the EPA target values, there is no need to conduct any risk-based remedial action or develop remedial action objectives.

However, additional considerations such as ARARs and removal actions under the NCP must be considered prior to developing an overall remedial action plan for the Ash Landfill. The following sections discuss these criteria in order to evaluate necessary remedial actions.

2.2.4 ARAR-Based Remedial Action Objectives

The investigation and clean-up of the Ash Landfill falls under the jurisdiction of both the State of New York regulations (administered by NYSDEC) and Federal regulations (administered by USEPA Region II). Three categories of potentially applicable state and federal requirements are reviewed separately in the subsequent subsections. The three categories of ARARs are: chemical-specific, location specific and action specific. A brief regulatory discussion of ARARs is given below.

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 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 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.

Any standard, requirement, criterion, or limitation under any federal 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.

As mentioned earlier in this section, three categories of ARARs were analyzed. The are as follows: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs address certain contaminants or a class of contaminants and relate to the level of contamination allowed for a specific pollutant in various environmental media (water, soil, air). Chemical-specific ARARs are discussed below, in the media-specific sections. 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. Both location-specific and action-specific ARARs are independent of the media. In addition to ARARs, advisories, criteria or guidance may be evaluated as "To Be Considered" (TBC) regulatory items. CERCLA indicates that the TBC category could include advisories, criteria or guidance that were developed by EPA, other federal agencies or states that may be useful in developing CERCLA remedies. These advisories, criteria or guidance are not promulgated and, therefore, are not legally enforceable standards such as ARARs.

2.2.4.1 Chemical-Specific ARARs and To Be Considered (TBCs)

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. A number of federal and state regulations are potential ARARs for this site. For each of the ARARs listed below 4 categories of information are provided.

Air Quality

- 40 CFR Part 50.8 (applicable): Ambient Air Quality Standard for Carbon Monoxide. Carbon monoxide concentrations in the ambient air shall not exceed the following hourly average, 35 parts per million (ppm); 8-hour average, 9 ppm. Consideration: This standard for carbon monoxide may apply to air emissions for a removal action or other remedial activities.

- 40 CFR Part 50.12 (applicable): Ambient Air Quality Standard for Lead. Lead concentrations in the ambient air shall not exceed 1.5 micrograms lead per cubic meter of air, 90-day average. Consideration: This standard for lead may apply to air emissions for a removal action or other remedial activities.

- 40 CFR Part 50.9 (applicable): Ambient Air Quality Standard for Ozone. Ozone concentrations in the ambient air shall not exceed 0.10 ppm hourly average. Consideration: This standard for ozone may apply to air emissions for a removal action or other remedial activities.

- 40 CFR Part 50.6 (applicable): Ambient Air Quality Standard for PM-10. PM-10 concentrations in the ambient air shall not exceed the following: 24 hour average, 150 micrograms per cubic meter of air; annual average, 50 micrograms per cubic meter of air. Consideration: This standard for PM-10 may apply to air emissions for a removal action or other remedial activities.

- 40 CFR Part 61 (applicable and relevant and appropriate): National Emission Standards for Hazardous Air Pollutants. This regulation requires the minimization of emissions, specifies emissions tests and monitoring requirements, and sets limits on several hazardous air pollutants. Consideration: These standards may apply to air emissions for a removal action or other remedial activities.

- 40 CFR Part 58 (applicable): Ambient Air Quality Surveillance. This part defines quality assurance requirements, monitoring methods, instrument siting, and operating schedule for ambient air quality surveillance. Consideration: These ambient air quality standards may apply to removal actions or other remedial activities.

- 40 CFR Part 52 (applicable): Approval and Promulgation of Implementation Plans. This part defines general provisions for the contents of State Implementation Plans (SIPs). Consideration: These provisions may apply to removal actions or other remedial activities at the Ash Landfill.

- 6 NYCRR Part 256 (applicable): Air Quality Classification System. This regulation defines four general levels of social and economic development for geographical areas in New York. These levels range from Level I, which would be used for timber, dairy

farming or recreation and would be sparsely populated, to Level IV, which would be densely populated with large commercial metropolitan office buildings or areas of heavy industry. Consideration: SEAD is classified as Level II, which is an area of predominantly single and two family residences, small farms and limited commercial services and industrial development.

- 6 NYCRR subpart 257-1 (applicable): Air Quality Standards General. This section of the air regulations defines what an air standard is, how the standard will be applied and what compliance with these standards will entail. Consideration: These standards may apply to a removal action or other remedial activities at the Ash Landfill.

- 6 NYCRR subpart 257-3 (applicable): Air Quality Standards-Particulates. Suspended particulates shall not exceed 250 mg/m^3 more than once a year. Annual standard -55 $\mu g/m^3$, 30-day standard - 100 $\mu g/m^3$, 60-day standard - 85 $\mu g/m^3$, 90-day standard - 80 $\mu g/m^3$, standard for settleable solids - 50 percent of the values of the 30 day average concentrations shall not exceed 0.30 $mg/cm^2/mo$; - 84 percent shall not except 0.45 $mg/cm^2/mo$. Consideration: These standards may apply to a removal action or other remedial activities at the Ash Landfill.

- 6 NYCRR subpart 257-4 (applicable): Air Quality Standards for Carbon Monoxide. Eight hour standard - 9 ppm, 1 hour standard 35 ppm. Consideration: The carbon monoxide standard may apply to a removal action or other remedial activity at the Ash Landfill site.

- 6 NYCRR subpart 257-6 (applicable): Air Quality Standards - Hydrocarbons (non methane). Three hour standard measured from 6 to 9 am - 0.24 ppm. Consideration: The hydrocarbon standard may apply to a removal action or other remedial activity at the Ash Landfill site.

Water Quality (these ARARs are also summarized in Table 2-2)

40 CFR Part 131 (applicable): Water Quality Standards. This part implements Section 101 of the Clean Water Act (CWA), which specifies the national goals of eliminating the discharge of pollutants, prohibiting the discharge of toxic pollutants in toxic amounts, and implementing programs for control of nonpoint sources. Consideration: All actions previously performed at the

Table 2-2
Water Quality Criteria for Compounds Present in Groundwater
Seneca Army Depot Activity - Ash Landfill Remedial Action

Analytes/Parameters	Federal SDWA MCLs (a)	Federal SDWA MCLGs (a)	Federal SDWA Secondary MCLs (a)	New York DWQS (b)	Federal AWQC to Protect Human Health (c) W & F	Federal AWQC to Protect Human Health (c) F	Federal AWQC to Protect Aquatic Life (c) Acute	Federal AWQC to Protect Aquatic Life (c) Chronic	NYSDEC Class GA Standards (d)	NYSDEC Class D Standards (d)
pH (standard units)			6.5-8.5	6.5-8.5			6.5-9			6.0-9.5
Total Dissolved Solids (mg/L)			500		250					
Common Anions (mg/L)										
Bromide									2	
Chloride			250	250			860	230	250	
Fluoride	4	4	2	2.2					1.5	0.003 h,A
Nitrate/nitrite (as nitrogen)	10	10		10	10				10	
Sulfate	400	400	250	250					250	
Metals (mg/L)										
Aluminum			0.05	0.05	e		e			
Antimony	0.006	0.006		0.006	0.014	45	0.088	0.03	0.003	
Arsenic	0.05	0.05		0.05	1.80E-06	0.00014	0.36 g	0.19 g	0.025	0.36 A
Barium	1	2		2	1				1	
Beryllium	0.004	0.004		0.004	7.60E-06	0.000131	0.13	0.005	0.003	
Cadmium	0.01	0.005		0.005	0.01	0.17	0.0039 h	0.001 h	0.01	0.004 h,A
Calcium										
Chromium (VI)	0.05 f	0.1 f		0.01	0.17	3.4	0.016	0.011 h	0.05	0.016 A
Chromium (III)	0.05 f	0.1 f		0.01	33		1.7 h	0.21 h	0.05	1.74 h,A
Copper	1.3	1.3	1	1.3	1.3		0.018 h	0.012 h	0.2	0.018 h,A
Iron			0.3	0.3	0.3			1	0.3	0.3 A
Lead	0.05	0		0.015	0.05		0.082 h	0.0032 h	0.025	0.083 h,A
Magnesium									35	
Manganese				0.3	0.05	0.1			0.3	
Mercury	0.002	0.002	0.05	0.002	0.00014	0.00015	0.0024 h	0.00001	0.002	0.0002 B
Nickel	0.1	0.1		0.1	0.51	3.8	1.4 h	0.16 h		1.844 h,A
Selenium	0.01	0.05		0.01	0.104	6.8	0.02	0.005	0.01	
Silver	0.05		0.1	0.05	0.091		0.00092 h	0.00012	0.05	0.004 h,A
Sodium									20	
Vanadium										0.19 A
Zinc			5	5		10	0.12	0.11	0.3	0.321 h,A
Cyanide	0.2	0.2		0.2	0.7	21.5	0.022	0.0052	0.1	0.022 A

Table 2-2
Water Quality Criteria for Compounds Present in Groundwater
Seneca Army Depot Activity - Ash Landfill Remedial Action

Analytes/Parameters	Federal SDWA MCLs (a)	Federal SDWA MCLGs (a)	Federal SDWA Secondary MCLs (a)	New York DWQS (b)	Federal AWQC to Protect Human Health (c) W & F	Federal AWQC to Protect Human Health (c) F	Federal AWQC to Protect Aquatic Life (c) Acute	Federal AWQC to Protect Aquatic Life (c) Chronic	NYSDEC Class GA Standards (d)	NYSDEC Class D Standards (d)
Volatile Organics (ug/L)										
Vinyl chloride	2	0		2	2	525			2	
1,1-Dichloroethene	7	7		5 i	0.057	3.2	11600 k		5	
1,1-Dichloroethane				5 i					5	
cis-1,2-Dichloroethene	70	70		5 i			11600 k		5	
trans-1,2-Dichloroethene	100	100		5 i	700	140000	11600 k		5	
Chloroform	100 j			100 j	5.7	470	28900	1240	7	
1,2-Dichloroethane	5	0		5 i	0.38	99	118000	20000	5	
1,1,1-Trichloroethane	200	200		5 i	3100	170000			5	
Trichloroethene	5	0		5 i	2.7	81	45000	21900	5	11 B
Benzene	5	0		5 i	1.2	71	5300		0.7	6 B
4-methyl-2-pentanone				50 l						
Tetrachloroethene	5	0		5 i	0.8	8.85	5280	840	5	1 B
Toluene	1000	1000		5 i	10000	300000	17500		5	
Ethylbenzene	700	700		5 i	3100	29000	32000		5	
Xylenes (total)	10000	10000		5 i					5	
Semivolatile Organics (ug/L)										
Phenol				50 l	21000	4600000	10200	2560	1	5 A
bis(2-chloroethyl)ether									1	
4-methylphenol									1	5 A
Naphthalene				50 l			2300	620	10	
2-Methylnaphthalene				50 l						
Diethylphthalate				50 l			940 m	3 m	50	
Pentachlorophenol									1	1 A
Dibutylphthalate				50 l	2700	12000	940 m	3 m	50	
Chlorinated Herbicides (ug/L)										
Dalapon	200	200		50					50	
Dicamba				0.44					0.44	

Note:

SDWA = Safe Drinking Water Act.
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
DWQS = New York Primary Drinking Water Quality Standard
AWQC = EPA ambient water quality criteria.
A = Fish survival or wildlife consumption of fish
B = bioaccumulation
mg/L = milligrams per liter.
ug/L = micrograms per liter.
Secondary MCLs are not potential ARARs but are To Be Considered (TBCs) and have been included for comparison purposes only

(a) 40 CFR 141
(b) 10 NYCRR Part 5
(c) Water Quality Criteria Summary, US EPA, 1991
(d) 6 NYCRR Parts 701 - 705, and NYS TOGS 1.1.1, November 15, 1991
(e) pH Dependent Criteria
(f) Value for total chromium.
(g) Value for trivalent arsenic.
(h) Hardness-dependent criteria assumes water hardness of 100 mg/L calcium carbonate.
(i) Value for listed principle organic contaminants; total for principle and unspecified organic contaminants may not exceed 100 ug/L.
(j) Value for total trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
(k) Value for total dichloroethenes.
(l) Value for listed unspecified organic contaminants; total for principle and unspecified organic contaminants may not exceed 100 ug/L.
(m) Value for total phthalate esters.

Ash Landfill site were in accordance with this Act and any future removal actions or other remedial measures must be conducted in order to comply with the goals of this act.

- 40 CFR Part 131.12 (applicable): Antidegradation Policy. Establishes standards to prevent a body of water which has an existing high standard from degrading to a lower standard. Consideration: All action previously performed at the Ash Landfill site complied with this policy and any future remedial measures must also comply with this Policy.

- 40 CFR Part 141 (applicable): National Primary Drinking Water Regulations. This part establishes primary drinking water regulators pursuant to Section 1412 of the Public Health Service Act as amended by the Safe Drinking Water Act. Consideration: MCLs and NY state groundwater standards (GA) were used as a frame of reference for the applicable constituents; the lower of the two standards were used to set clean-up levels in groundwater at the Ash Landfill site.

- 40 CFR Part 141.11 (applicable): Maximum Inorganic Chemical Contaminant Levels. This section establishes maximum contaminant levels (MCLs) for inorganic chemicals in drinking water including the following:

	Maximum Contaminant Level	
Metal	(mg/L)	(µg/L)
Arsenic	0.05	50
Barium	2.0	2000
Cadmium	0.005	5
Chromium	0.01	100
Lead	0.015*	5*
Mercury	0.002	2
Selenium	0.05	50

* Action Level

Consideration: MCLs and NY State groundwater standards (GA) were used as a frame reference for the applicable constituents; the lower of the two standards were used to set clean-up levels in groundwater at the Ash Landfill site.

- CFR Part 141.12 (applicable): Maximum Organic Chemical Contaminant Levels. This section establishes MCLs for organic chemicals in drinking water including the following:

	Maximum Contaminant Level	
Metal	(mg/L)	(µg/L)
TCE	0.005	5
Benzene	0.005	5
Total trihalomethanes	0.10	100

Consideration: MCLs and NY State groundwater standards (GA) were used as a frame of reference for the applicable constituents; the lower of the two standards were used to set clean-up levels in groundwater at the Ash Landfill site.

- 40 CFR Part 264 Subpart F (relevant and appropriate): Releases from Solid Waste Management Units. Standards for protection of groundwater are established under this citation. Consideration: These standards are relevant to appropriate to any impacts to groundwater at the Ash Landfill operable unit.

- 40 CFR Part 403 (applicable): Pretreatment Standards for the Discharge of Treated Site Water to a Publicly Owned Treatment Works (POTW). This part establishes pretreatment standards for the discharge of wastewater to POTWs. Consideration: These standards apply to any removal action or other remedial measure that might involve the discharge of treated site water to a POTW. If such a discharge system is installed at the Ash Landfill and the discharge is sent to a POTW, then a permit would be obtained from the POTW prior to the discharge.

- 6 NYCRR Chapter X (relevant and appropriate): This chapter establishes the requirements of the State Pollutant Discharge Elimination System. Consideration: These standards are relevant and appropriate discharges from remedial activities that occur at the site.

- 6 NYCRR subparts 701 and 702 (applicable): These subparts provide classification definitions for surface water and groundwaters and describe procedures that may be used to obtain guidelines or standards that will be protective of human health and aquatic life. Consideration: Definitions of local surface water and groundwater classifications at the site were obtained from these subparts.

- 6 NYCRR subpart 703 (applicable): This subpart establishes groundwater standards specified to protect groundwater for drinking water purposes. Consideration: The groundwater at Ash Landfill site has been classified as GA which means the best usage is as a source of potable water. Given the current and future intended uses of the site, these standards are the most appropriate for comparison to on-site concentrations. Also, groundwater effluent standards apply to a discharge from a point source or outlet (that may be associated with a remedial measure) that will or may enter the unsaturated or saturated zones.

- 6 NYCRR subpart 375 (relevant and appropriate): This subpart contains the New York State rules for inactive hazardous waste disposal sites. Consideration: These rules, in the future, are relevant and appropriate to the Ash Landfill site operable unit.

- 6 NYCRR subpart 373-2.6 and 373-2.11 (applicable): This regulation requires groundwater monitoring for releases from solid waste management units. Consideration: A quarterly groundwater monitoring has been conducted on the Ash Landfill site since 1987 and will continue to be implemented.

- 6 NYCRR subpart 373-2 (relevant and appropriate): This regulation establishes postclosure care and groundwater monitoring requirements. Consideration: This regulation applies after the Ash Landfill site has been closed under CERCLA requirements.

- 10 NYCRR Part 5 (relevant and appropriate): This regulation establishes criteria for drinking water supplies. Specifically, NYSDOH has established MCLs for water. Consideration: These criteria are relevant and appropriate to drinking water sources in NY State.

- NYSDEC TOGS 1.1.1 (relevant and appropriate): This document compiles water quality standards and guidance values for use in NYSDEC programs. Consideration: This document was used as a reference for the NYSDEC water quality standards and guidance values.

Soil Quality

- 40 CFR Part 268 (relevant and appropriate): Land Disposal Restrictions (LDR). Restricts the disposal of listed and characteristic hazardous waste which contain hazardous constituents exceeding designated levels. Only applies when the waste is "placed" on the land. Consideration: For this site, only the restrictions on land disposal of Toxicity Characteristic (TC) hazardous wastes are ARARs, since there are no F or K listed wastes onsite. Specifically, it has been assumed that the characteristic for D040 (trichloroethene) would apply since it is likely that this characteristic would exceed TCLP limits, based upon existing groundwater quality. Accordingly, if soil is excavated the LDR are considered an ARAR.

- 40 CFR subpart S parts 264.552 and 264.533 (relevant and applicable): Corrective Action for Solid Waste Management Units. Allows for the consolidation of wastes, or the replacement of remediated wastes in land based units without invoking the RCRA land-disposal requirement of 40 CFR 268. Consideration: These parts are relevant and appropriate during a removal action or other remedial measures at the Ash Landfill site.

- NYSDEC Technical and Administrative Guidance Manuals (TAGMs) (To Be Considered): The New York State rules for inactive hazardous waste disposal sites are provided in these documents. Cleanup levels for hazardous constituents in soil have been proposed by the State of New York through Technical and Administrative Guidance Manuals (TAGMs) specifically, #HWR-92-4045. Consideration: The NYSDEC TAGM manual for cleanup levels for soils is #HWR-92-4046 and has been used as guidance for this remedial action. These levels are shown in Table 2-3 and 2-4 for constituents detected at the Ash Landfill. The TAGMs are "To Be Considered" guidelines and are not ARARs. The primary chemicals of concern at the Ash Landfill are chlorinated hydrocarbons, specifically TCE, DCE, and vinyl chloride. A review of the data presented in Section 2.0 indicates that some semi-volatile organic compounds and some metals also exceed the established TAGM values. Site Cleanup Goals (SCG) for metals have been determined as

Table 2-3
Comparison with NYSDEC TAGM Soil Cleanup Guidelines (SCG)s and Soil Sample Results

Parameter	**USEPA Health-Based Value (1) (mg/kg)**	**Protect Water Quality (2) (mg/kg)**	**Recommended Soil Cleanup Objective (3) (mg/kg)**	**Maximum Value Detected (mg/kg)**	**95th UCL of the Mean (mg/Kg)**
Volatile Organics					
Trichloroethene	64	0.7	0.7	540	2.268
1,2-Dichlororethene (total)	2000	0.3	0.3	79	1.713
Vinyl Chloride	NA	0.12	0.2	14.5	0.062
Total Volatile Organics			10		NA
Semivolatile Organics					
Benzo(b)fluoranthene	NA	1.1	1.1	9.5	0.498
Benzo(k)fluoranthene	NA	1.1	1.1	6.7	0.469
Benzo(a)pyrene	0.0609	11	0.061 or MDL (4)	9.0	0.491
Indeno(1,2,3-cd)pyrene	NA	3.2	3.2	4.8	0.431
Dibenzofuran	NA	6.2	6.2	7.0	0.4
bis(2-ethylhexyl)phthalate	50	435	50	230	0.715
Benzo(a)anthracene	0.224	3	0.22 or MDL (4)	9.6	0.52
Dibenzo(a,h)anthracene	0.0143	165000	0.014 or MDL (4)	2.9	0.41

References:

1. U.S. EPA Health Effects Summary Tables (HEASTs)
2. Derived from partitioning calculations, i.e., Koc x foc x GA groundwater standard.
3. NYSDEC TAGM #HWR-92-4046, November 16, 1992
4. MDL- minimum detection limit. For semi-volatile organics the MDL is approximately 0.33 mg/Kg.

Table 2-4
Comparison with Metals Soil Cleanup Guidelines (SCG)s
Soil Sample Results

Total Metals	Average Range in Eastern U.S. Soils (1) (mg/kg)	Site Background Value (2) (mg/kg)	Recommended Soil Cleanup Objective (1) (mg/kg)	Limiting Value SCG (mg/kg)	Maximum Value Detected (mg/kg)	95 UCL of the Mean (mg/Kg)
Aluminum	33,000	17,503	SB	17,503	25500	NA
Antimony	Not Available	5.2	SB	5.2	12.3	NA
Arsenic	3-12 *	5.9	SB or 7.5	7.5	45.8	NA
Barium	15-600	101.8	SB or 300	300	211	NA
Beryllium	0-1.75	1.0	SB or 1.0	1.0	1.1	NA
Cadmium	0.1-1	1.8	SB or 1.0	1.8	43.1	3.84
Calcium	130-35,000 *	46,825	SB	46,825	172000	NA
Chromium	1.5-40 *	26.6	SB or 10	26.6	62	27.72
Cobalt	2.5-60 *	15.3	SB or 30	30	18.1	NA
Copper	1-50	24.1	SB or 25	25	836	40.46
Iron	2,000-550,000	32,698	SB or 2,000	32,698	86400	NA
Lead	4-61	14.0	SB or 30	30	2890	90.05
Magnesium	1,000-5,000	9071.1	SB	9071.1	24900	NA
Manganese	50-5,000	1065.8	SB	1065.8	1700	NA
Mercury	0.001-0.2	0.1	0.1	0.1	0.76	NA
Nickel	0.5-25	41.3	SB or 13	41.3	54.5	NA
Potassium	8,500-43,000 *	1529.6	SB	1529.6	2750	1951.81
Selenium	0.1-3.9	0.4	SB or 2.0	2.0	1.8	NA
Zinc	9-50	89.1	SB or 20	89.1	55,700	409.06

* New York State Background Concentration

References:

1. NYSDEC TAGM # HWR-92-4046, November 16, 1992.
2. Draft RI Report for Seneca Army Depot Ash Landfill,
   ES 1993

SB - Site Background

NA - Not Aplicable because the constituent was eliminated from risk based on a statistical comparison to background; see Section 6.2.3 (the risk assessment) of the Ash Landfill RI report.

either the site background concentration or the NYSDEC TAGM value, whichever is higher. The background metal concentration value has been determined as the 95th Upper Confidence Limit (UCL) of the mean for the background soil samples collected from the entire SEAD facility. TAGMs are being considered as remedial goals for volatile organics for the remedial measure.

PCBs

- Part 761 (TBC): Polychlorinated Biphenyls (PCBs) Manufacturing, processing, distribution in commerce and use prohibition. This part establish and the requirements for the storage and disposal of PCBs. Consideration: No action is required in regard to this regulation.

- Part 761 subpart G (TBC): PCB Spill Clean Up Policy, This regulation establishes criteria EPA will use to determine the adequacy of the clean up of spills resulting from the release of materials containing PCBs. Consideration: No action is required in regard to this regulation since none of the concentrations of PCBs in soil or water at the Ash Landfill are greater than the action limit of than 50 ppm.

- EPA OSWER 8/90 (TBC): A Guide to Remedial Actions at Superfund sites with PCB contamination. Consideration: No action is required in regard to this document because none of the PCB concentrations in soil and water at the Ash Landfill are greater than the action limit of 50 ppm.

2.2.4.2 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 are listed below.

Endangered Species

- 40 CFR Part 257.3-2 (relevant and appropriate): Facilities or practices shall not cause or contribute to the taking of any endangered or threatened species. Consideration: A site survey for endangered species was performed during the Ash Landfill field program. No endangered species were observed. A letter from the U.S. Fish and Wildlife Service (USFWS) indicated no known endangered species existed at the site.

Location Standards

- 40 CFR Part 264.18 (relevant and appropriate): Location Standards for Hazardous Waste Facilities. The general requirements for locating a hazardous treatment, storage, or disposal facility are found in this section. They include provisions for seismic considerations and floodplains. Consideration: These standards are relevant and appropriate to remedial measures instituted at the Ash Landfill.

- 40 CFR Part 241.202 (applicable): Site selection shall be consistent with public health and welfare. It shall also be consistent with land-use plans and air and water quality standards. Consideration: These standards apply to remedial measures instituted at the Ash Landfill site.
- 40 CFR Part 230-Section 404(b)(1) (applicable): Guidelines for Specifications of Disposal sites for dredged or filled material. The purpose of these guidelines is to restore and maintain the chemical, physical, and biological integrity of waters (including wetlands) of the United States through control of dredged or fill material. Considerations: No permit is required under Section 404, however, wetland restoration is required for remedial activities selected for the Ash Landfill.

- Wetlands Executive Order (EO1199) (applicable): Under this regulation federal agencies are required to minimize the destruction, loss, or degradation of wetlands and preserve and enhance natural and beneficial values of wetlands. Consideration: Remedial alternatives that involve construction must include all practical means of minimizing harm to wetlands.

Antiquities

- USC Part 469a-1 (applicable): The Archaeological and Historic Preservation Act requires that action be taken to recover and preserve artifacts. Consideration: An archeological

survey is currently underway and will be completed shortly. A preliminary survey conducted in 1986 titled "An Archeological Overview and Management Plan for Seneca Army Depot," did not suggest any known archeological or historical site existed within the site boundaries.

- 40 CFR Part 800 (relevant and appropriate): Action must be taken to preserve historic properties. Actions must be planned to minimize harm to national historic landmarks. Consideration: As previously mentioned, a site archeological survey is currently underway. A preliminary archeological survey did not indicate that any historic properties exist on the site.

2.2.4.3 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 which may apply include the following:

Solid Waste Management

- 40 CFR Part 241.100 (relevant and appropriate): Guidelines for the Land Disposal of Solid Wastes. These regulations are geared specifically toward sanitary landfills; however, they are applicable to all forms of land disposal and land-based treatment. Consideration: These regulations are relevant and appropriate to land disposal or land-based treatment that may be established as part of remedial measures at the Ash Landfill.

- 40 CFR Part 241.204 (applicable): Water Quality. The location, design, construction, and operation of land disposal facilities shall protect water quality. Consideration: These regulations apply to land disposal facilities that may be established as part of remedial measures at the Ash Landfill site.

- 40 CFR Part 241.205 (applicable): The design, construction, and operation of land disposal facilities shall conform to air quality and source control standards. Considerations: These standards are applicable to land disposal facilities that may be established as part of remedial measures on the Ash Landfill site.

- 40 CFR Part 257.1 (relevant and appropriate): This part establishes the scope and purpose of criteria for use in assessing the possibility of adverse effects on health or the environment from solid waste disposal operations. Consideration: This part is relevant and appropriate to solid waste disposal operations that may be established during remedial activities at the Ash Landfill site.

- 40 CFR Part 257.3 (relevant and appropriate): This part establishes criteria to assess the impact of disposal operations, including such considerations as floodplains, endangered species, air, surface water, groundwater, and land used for food-chain crops. Consideration: This part is relevant and appropriate to disposal operations performed during remedial activities at the Ash Landfill site.

- 40 CFR Part 243.202 (relevant and appropriate): This part specifies the requirements for transporting solid waste, including provisions to prevent spillage. Consideration: This part is relevant and appropriate to remedial measures that involve transporting of solid waste.

- 6 NYCRR Part 360: Subtitle D Solid Waste Landfills (applicable). Consideration: Applies to remedial alternatives using capping options.

Hazardous Waste Management

- 6 NYCRR Part 360: Subtitle D Solid Waste Landfills (applicable). Consideration: Applies to remedial alternatives using capping options.

- FR 262.11 (applicable): This regulation requires a person who generates a solid waste to determine if that waste is a hazardous waste. Consideration: This part is applicable if solid waste is disposed of as part of remedial measures.

- 40 CFR Part 263.30 and 263.31 (relevant and appropriate): These regulations set forth the standards and requirements for action in the event of a release during transport. Consideration:

These regulations are relevant and appropriate if the transport hazardous wastes is part of a remedial measure at the Ash Landfill site.

- 40 CFR Part 264 (relevant and appropriate): This part establishes hazardous waste management facility standards and requirements. The on-site disposal areas used for stockpiling, mixing, and extended bioremediation of wastes must meet the substantive requirements of 40 CFR subparts B (general facility standards), E (manifest system, record keeping, and reporting), F (releases from solid waste management units), G (closure and postclosure), L (waste piles), M (land treatment), and N (landfills). These regulations are applicable for hazardous wastes and are also relevant and appropriate for certain wastes which are not hazardous wastes. Consideration: These hazardous waste management facility standards and requirements are relevant and appropriate to on-site disposal areas established for remedial measures at the Ash Landfill site. Any facilities will be constricted, fenced, posted, and operated in accordance with this requirement. All workers will be properly trained. These standards would be applicable to any treatment or disposal facility operated on the site.

- 40 CFR Part 270 subpart C (relevant and appropriate): This regulation establishes permit conditions, including monitoring, recordkeeping requirements, operation and maintenance requirements, sampling, and monitoring requirements. Consideration: Although no permit is required for activities conducted entirely on site, the substantive requirements of these provisions are relevant and appropriate to the Ash Landfill site.

- 40 CFR Part 270 subpart B (relevant and appropriate): This part defines the required contents of a hazardous waste management permit application. Consideration: The substantive requirements of these provisions are relevant and appropriate to the Ash Landfill site.

Occupational Health and Safety Administration

- 40 CFR Part 1910.50 (applicable): Occupational Noise. No worker shall be exposed to noise levels in excess of the levels specified in this regulation. Consideration: Adherence to occupational noise regulations has been a part of all previous on-site activities and all future work will also comply with these regulations.

- 40 CFR Part 1910.1000 (applicable): Occupational Air Contaminants. The purpose of this rule is to establish maximum threshold limit values for air contaminants to which it is believed nearly all workers may be repeatedly exposed day after day without adverse health effects. No worker shall be exposed to air contaminant levels in excess of the threshold limit values listed in the regulation. Consideration: Adherence to air contaminant regulations for on-site workers has been a part of all previous field programs at the Ash Landfill and all future work will also comply with these regulations.

- 40 CFR Part 1910.1200 (applicable): This part requires that each employer compile and maintain a workplace chemical list which contains the chemical name of each hazardous chemical in the workplace, cross-referenced to generally used common names. This list must indicate the work area in which each such hazardous chemical is stored or used. Employees must be provided with information and training regarding the hazardous chemicals. Consideration: The requirements of this part have been complied with during the performance of all previous work at the Ash Landfill site. All future work will also require compliance with this part.

- 40 CFR Part 120 (applicable): This part applies to employers and employees engaged in sites that have been designated for cleanup, and other work related to RCRA and CERCLA. The regulation establishes proceedings for site characterization and control, and requirements for employee training and medical monitoring. Consideration: The requirements of this part have been complied with during the performance of all previous work at the Ash Landfill site. All future work will also require compliance with this part.

Transportation of Hazardous Waste

- 40 CFR Part 120 (applicable): This part applies to employers and employees engaged in sites that have been designated for cleanup, and other work related to RCRA and CERCLA. The regulation establishes proceedings for site characterization and control, and requirements for employee training and medical monitoring. Consideration: The requirements of this part have been complied with during the performance of all previous work at the Ash Landfill site. All future work will also require compliance with this part.

- 40 CFR Part 171 (applicable): General information, regulations, and definitions. This regulation prescribes the requirements of the DOT governing the transportation of hazardous

material. consideration: This part may apply to remedial measures that require the transport of hazardous materials. Contaminated materials will be packaged, manifested, and transported to a licensed off-site disposal facility in accordance with these regulations.

- 40 CFR Part 172 (applicable): Hazardous materials table, special provisions, Hazardous Materials Communications, Emergency Response Information, and Training requirements. This regulation lists and classifies those materials which the DOT has designated to be hazardous materials for the purpose of transportation and prescribes the requirements for shipping papers, package marking, labeling and transport vehicle placarding applicable to the shipment and transportation of those hazardous materials. Consideration: This part may be applicable to remedial measures that require the shipment and transportation of hazardous materials.

- 49 CFR Part 177 (applicable): Carriage by Public Highway. This regulation prescribes requirements that are applicable to the acceptance and transportation of hazardous materials by private, common, or contract carriers by motor vehicle. Consideration: This part may be applicable to remedial measures that require this shipment and transportation of hazardous materials.

- 6 NYCRR Chapter 364 (applicable): New York Waste Transport Permit Regulation. This regulation governs the collection, transport, and delivery of regulated waste originating on terminating within the state of New York. Consideration: This regulation may be applicable to remedial measures that involve regulated waste.

- EPA/DOT Guidance Manual on hazardous waste transportation (TBC). Consideration: This information contained in this manual will be considered for remedial measures that involve hazardous waste transportation.

2.2.5 Removal Action Remedial Objectives

A non-time critical removal action was performed on soils at the "Bend in the Road" at the Ash Landfill. This removal action was performed to address the source of VOCs in soils. A description of the regulations pertaining to removal actions, as well as the site-specific removal action remedial objectives are discussed below.

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 of 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 a 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 remain before response actions must begin. Non-time-critical removals are those in which it is determined that more that 6 months may pass before response actions must begin.

Investigations of the SEDA Ash Landfill indicated that soils at this site posed a potential threat to human health and the environment through soil ingestion or dermal contact, and through continued leaching to the groundwater. As part of an Action Memorandum, an Engineering Evaluation/Cost Analysis an EE/CA was prepared (ES May 1994) to document the identification and evaluation of removal action alternatives in support of a voluntary non-time critical removal action. This document recommended a removal action for soils in the "Bend in the Road" to remove the source of volatile organics which continue to leach into groundwater over time thereby causing groundwater to exceed State GA groundwater quality standards and exceed ARARs.

The removal action for soils at the "Bend in the Road" was performed from August 1994 through June 1995 using a LTTD system (Section 1.6); this was done in order to expedite the RI/FS process. In addition, although the existing risk analysis does not suggest the risks at the site are unacceptable, the benefit of performing the removal action is that it reduces site risks from inhalation and soil contact exposure pathways under the current and intended future site scenarios.

The objectives of the removal action were to treat VOCs and PAHs in soils at the two areas (Areas A and B) near the "Bend in the Road" so that the concentrations of these constituents are below acceptable clean-up levels; this would also remove the source of the plume of VOCs that has impacted groundwater at the site. The major activities that were performed during the removal action to meet these objectives are presented below:

- Confirm the extent of the known soil impacts in order to delineate the areas to be excavated and treated.

- Treat impacted soils with LTTD to remove VOCs to prescribed clean-up concentrations and to reduce the concentrations of PAHs in the soil.

- Treat water collected from the excavation with an air stripping system that has particulate filtration and, after confirmatory sampling, discharge it to the ground surface.

- Backfill the Ash Landfill with treated soil.

- Measure and control the dispersion of air pollution resulting from the processes related to the treatment activities.

Cleanup requirements for soils treated with LTTD were derived from the NYSDEC TAGM #HWR-92-4046. For this site, cleanup requirements were established for the principle volatile organic and polynuclear aromatic contaminants of concern at the site. These requirements (in µg/kg) are as follows:

Trichloroethene (TCE)	700
1,2-Dichloroethene (DCE)	300
Vinyl chloride (VC)	200
Toluene	1,500
Xylene	1,200
Bis(2-ethylhexyl)phthalate	50,000
Pyrene	50,000
Fluoranthene	50,000
Phenanthrene	50,000
Benzo(a)pyrene	61
Indeno(1,2,3-cd)pyrene	3,200
Naphthalene	13,000
Chrysene	400
Benzo(a)anthracene	220
Dibenzo(a,h)anthracene	14

With regard to debris encountered during the removal action, all metal, glass, rubber, and plastic debris was treated so that all foreign matter was removed and a "clean debris surface" was produced. A "clean debris surface" is defined as a surface that, when viewed without magnification, is free of all soil, except that residual staining caused by soil and waste consisting of light shadows, slight streaks, or minor discolorations. Any debris that was small enough to pass through the thermal desorption unit was treated along with the soils.

The remedies achieved as a result of this removal action are considered in the development and screening of remedial action alternatives that are discussed in subsequent sections of the Ash Landfill FS.

2.2.6 Summary of the Result of the RAO Determination and Site Specific Clean-up Goals

2.2.6.1 Groundwater Clean-up Goals

The groundwater clean-up goals for the Ash Landfill are presented in Table 2-5. This table lists the constituents of concern that were retained after the site-specific data evaluation (Section 6.2.3 of the Ash Landfill RI) and were used in the baseline risk assessment. This table lists the clean-up goal and the ARAR basis for each clean-up goal. Ultimately, the groundwater clean-up goal will be to further reduce site risks. The acceptable EPA hazard index is less than 1.0 and the total cancer risk range is 10^{-4} to 10^{-6}.

Currently, both the site total hazard index (0.24) and the total cancer risk (1.0×10^{-4}) are within the EPA's acceptable risk range for the current and intended future land use scenarios (Table 2-6); this table also identifies the receptors and exposure routes. Volatile organics in groundwater do not pose a threat to human health because ingestion of on-site groundwater is not an exposure pathway under the current or intended future land use. The risks posed by other constituents (i.e., metals, SVOCs) fall within or below the EPA target ranges. Lastly, the plume of volatile organics extends off-site, although no constituent concentrations have been detected above the applicable ARARs.

2.2.6.2 Soil Clean-up Goals

The soil clean-up goals for the Ash Landfill are presented in Table 2-5. As noted above for the groundwater clean-up goals, the list of the constituents of concern was derived in the site specific data evaluation section of the Ash Landfill RI. The values for soil clean-up presented in NYSDEC

Table 2-5

Site-Specific Clean-up Goals for Media of Concern

Seneca Army Depot Activity
Ash Landfill Feasibility Study

SOIL

Constituent of Concern	Clean-up Goal (ug/Kg)	TBC
Volatile Organics		
Vinyl Chloride	200	NYSDEC TAGM
1,2-Dichloroethene (total)	300	NYSDEC TAGM
Trichloroethene	700	NYSDEC TAGM
Semivolatiles		
2-Methylnaphthalene	36,400	NYSDEC TAGM
Acenaphthylene	41,000	NYSDEC TAGM
Dibenzofuran	6,200	NYSDEC TAGM
Phenanthrene	50,000	NYSDEC TAGM
Benzo(a)anthracene	220 or MDL	NYSDEC TAGM
bis(2-Ethylhexyl)phthalate	50,000	NYSDEC TAGM
Benzo(b)fluoranthene	1,100	NYSDEC TAGM
benzo(k)fluoranthene	1,100	NYSDEC TAGM
Benzo(a)pyrene	61 or MDL	NYSDEC TAGM
Indeno(1,2,3-cd)pyrene	3,200	NYSDEC TAGM
Dibenz(a,h)anthracene	14 or MDL	NYSDEC TAGM
Benzo(g,h,i)perylene	50,000	NYSDEC TAGM
Pesticides/PCBs		
Aroclor-1260	1,000	NYSDEC TAGM
Metals		
Cadmium	1,800	NYSDEC TAGM(SB)
Chromium	26,000	NYSDEC TAGM(SB)
Copper	25,000	NYSDEC TAGM
Lead	500,000	Site-Specific goal
Zinc	89,100	NYSDEC TAGM (SB)

GROUNDWATER

Constituent of Concern	Clean-up Goal (ug/L)	ARAR
Volatile Organics		
Vinyl Chloride	2	NYSDEC AWQS (GA)
1,2-Dichloroethene (total)	5	NYSDEC AWQS (GA)
1,1,1-Trichloroethane	5	NYSDEC AWQS (GA)
Trichloroethene	5	NYSDEC AWQS (GA)
Semi-volatiles		
2-Methylnaphthalene		NA
Metals		
Aluminum		NA
Cadmium	10	NYSDEC AWQS (GA)
Chromium	50	NYSDEC AWQS (GA)
Copper	200	NYSDEC AWQS (GA)
Lead	25	NYSDEC AWQS (GA)
Nickel		NA
Zinc	300	NYSDEC AWQS (GA)

SEDIMENT

Constituent of Concern	Clean-up Goal (ug/Kg)	TBC
Semivolatiles		
2-Methylnaphthalene		NA
Acenaphthylene		NA
Phenanthrene	1,390	NYSDEC Criteria
Benzo(a)anthracene	130	NYSDEC Criteria
Benzo(b)fluoranthene	130	NYSDEC Criteria
Benzo(k)fluoranthene	130	NYSDEC Criteria
Benzo(a)pyrene	130	NYSDEC Criteria
Indeno(1,2,3-cd)pyrene	130	NYSDEC Criteria
Dibenz(a,h)anthracene		NA
Benzo(g,h,i)perylene		NA
Metals		
Aluminum		NA
Antimony		NA
Arsenic	5,000	NYSDEC Criteria
Barium		NA
Beryllium		NA
Cadmium	800	NYSDEC Criteria
Chromium VI	26,000	NYSDEC Criteria
Cobalt		NA
Copper	19,000	NYSDEC Criteria
Lead	27,000	NYSDEC Criteria
Manganese	428,000	NYSDEC Criteria
Nickel	22,000	NYSDEC Criteria
Thallium		NA
Vanadium		NA
Zinc	85,000	NYSDEC Criteria

SURFACE WATER

Constituent of Concern	Clean-up Goal (ug/L)	ARAR
Volatile Organics		
Chloroform		NA
Metals		
Aluminum		NA
Antimony		NA
Arsenic	360	NYSDEC AWQS (D)
Beryllium		NA
Chromium		NA
Cobalt	110	NYSDEC AWQS (D)
Copper	65.4	NYSDEC AWQS (D)
Lead	477.8	NYSDEC AWQS (D)
Manganese		NA
Nickel	5,289.7	NYSDEC AWQS (D)
Zinc	1,015.3	NYSDEC AWQS (D)

Notes:
1) NYSDEC TAGM = values are based on Technical Administrative Guidance Memorandum HWR-92-4046, November 16, 1992. SB indicates that the site background for soil was used.
2) MDL = Minimum Detection Limit; for semivolatile organic compounds the MDL is 330 ug/Kg.
3) NYSDEC AWQS (GA) = values are based on Water Quality Standards for Class GA groundwaters. From 6 NYCRR Subparts 701 - 705.
4) NYSDEC Criteria = values are based on Sediment Criteria, December, 1989.
5) NYSDEC AWQS (D) = values are based on Water Quality Standards for Class D surface waters. From 6 NYCRR Subparts 701 - 705.
6) NA = Not Available.
7) TBC = To Be Considered
8) ARAR = Applicable or Relevant and Appropriate Requirement

TAGM #HWR-92-4046 are to be considered (TBCs) because they are not promulgated standards. These values are not used to determine the necessity of remediation but are used as guidelines in setting the remedial goals.

As noted above in the groundwater clean-up goals section, the site hazard index and total cancer risk are within the acceptable EPA risk range. However, the most significant risk comes from several exposure routes most notably soil ingestion, dermal contact with soil, and inhalation of compounds that volatilize from surface soils. These risks, however, were reduced by the non-time critical removal action that was performed on the source of the VOCs in soils near the "Bend in the Road".

Lead was not considered as part of the risk assessment because the EPA has withdrawn the allowable Reference Dose (RfD) value for lead. A site-specific clean-up goal for soil and on-site sediment was established at 500 mg/kg for lead as part of the Feasibility Study for the OB Grounds. This clean-up goal has been adopted for the Ash Landfill.

2.3 GENERAL RESPONSE ACTIONS

Remedial Action Objectives for the Ash Landfill are based upon two criteria. The first criteria is the need to achieve acceptable risk for the intended land use and the second is to achieve compliance with all ARARs. As previously discussed, the BRA has concluded that for the intended use of this land, which is as a meadow, the risks to human health are acceptable. However, the groundwater quality does exceed the current New York State Classification standard of GA for trichloroethene and the breakdown products dichloroethene and vinyl chloride. This requires consideration of remedial actions to improve the quality of the groundwater to that required by the GA groundwater standard.

The ecological risk analysis suggested that, based upon a comparison with all available state and federal guidelines, in addition to literature information, there may exist a slight threat due to the presence of heavy metals. However, field observations and ecological monitoring data indicated that a diverse, healthy ecological community exists at the site. These observations and data are consistent with the aforementioned guideline comparison evaluation that suggested if any slight increased risks exist these risks would be manifested in an increase in chronic (longterm) effects and therefore would not be readily apparent. Additionally, the uncertainty associated with the characterization of ecological risks further contributes to the contention that the evidence does not

currently require a remedial action, especially since no ecological based ARAR has been exceeded by the site conditions.

The Remedial Action Objectives for this site include improving the quality of the groundwater to the quality of GA. Strides have already been made to achieve this objective through the implementation of the non-time critical removal action described in Section 1.6. Since there are no soil ARARs available, the remediation objectives and volumes of soil that have been established as requiring treatment for this action were determined by considering the NYSDEC TAGM values for soil clean-up. Based upon the risk analysis, the soil remediation for VOC constituents was not a requirement. Because a clearly defined source of groundwater impacts by VOCs was apparent, elimination of this source hastened the improvement of groundwater quality. Additionally, although the total site risks for the current and intended future land uses do not exceed the maximum EPA carcinogenic risk target value of 1×10^{-4}, the value is very close to this limit and it is likely to have been reduced by removal action. The most significant contributor to this total site risk value was due to the inhalation of volatiles being emitted from the source soils.

The non-time critical removal action accomplished the following:

- Eliminated continued leaching of volatile organics to groundwater from on-site soils.
- Mitigated exposure pathways for inhalation of volatile organics and dermal and ingestion of volatile organics in soils for current and intended future site-use scenarios thereby decreasing the risk to human health.
- Complied with NYSDEC Soil Clean-up TAGM values for volatile organics.
- Decreased the risk to ecological receptors.

Again, while the risk analysis indicates that soil remediation is not a requirement, the ecological risk assessment does suggest that metals, albeit small, may be a source of increased chronic risk. Several constituents exceed NYSDEC TAGM values recommended for site clean-up and, although these TAGM values are not ARARS, they still must be considered in the analysis. Since the areas at the site were not capped with an engineered cap and areas such as the Ash Landfill and the debris piles are at the surface, there is a need to consider improving the condition of these areas.

This feasibility study will consider areas and volumes of soil which will address these remedial action objectives.

In summary, soils/sediment and groundwater remedial action alternatives will be developed for the reasons cited below. Soils/sediment remedial action alternatives will be developed to accomplish the following:

- Mitigate exposure pathways for dermal contact and ingestion of metals and PAHs for current and intended future site use scenarios, thereby decreasing risk to human health and the environment

- Comply with NYSDEC soil clean-up TAGM values (TBCs) for inorganics (metals) and PAHS.

Development of groundwater remedial action alternatives will accomplish the following:

- Comply with NYSDEC soil clean-up TAGM values (TBCs) for inorganics (metals) and PAHS.

- Comply with ARARs for Federal or New York State GA groundwater quality standards.

- Reduce and improve non-carcinogenic and cancer risk levels for current and intended future receptors.

- Prevent exposure to off-site receptors through possible off-site migration of the VOC plume.

For groundwater, this feasibility study will consider options that will improve the quality of the existing plume and manage the migration of this plume off-site. Unlike soil, the groundwater plume will be considered as a whole.

As discussed in previous sections, remedial action objectives and site-specific cleanup goals were developed for the two media of concern, groundwater and soil. The Remedial Action Objectives for soil focus on mitigating exposure pathways for dermal contact and ingestion of metals and PAHs. To achieve these objectives for soil, three areas of the site, the Ash Landfill, debris piles, and NCFL, must be excavated, treated, or covered. For groundwater, the Removal Action

conducted for source soils at the "Bend in the Road" was performed to remove the source of volatile organics which continue to leach into the groundwater. This Removal Action involved treatment of VOCs and PAHs in soils at the two areas designated as Areas A and B. Because the source of the groundwater plume has been removed, the Remedial Action Objectives for groundwater now involve management of the VOC plume which includes improving the quality of the existing plume and managing the migration of the plume off-site. Therefore, assembling and screening of alternatives have been conducted separately in terms of Source Control for soil/sediment and Migration Control for the groundwater plume because the technologies, remedial actions, and constituents of concern for Source Control and Migration Control are clear and distinct for each media. Furthermore, separation of Source Control actions and Migration Control actions provides a more effective means of implementing a remedial action as evidenced by the non-time critical removal action performed by the Army for soils at the "Bend in the Road". That is, Remedial Action Objectives for each media may be achieved more effectively by developing and conducting the alternatives independently of one another.

Completion of the Removal Action for the source of the groundwater plume has minimized the interaction between the soil and the groundwater media. According to Section 4.2.6 of the CERCLA RI/FS Guidance Manual (USEPA, 1988), if interactions between the two media are not significant, an FS may describe options by media instead of on a sitewide basis. This approach permits greater flexibility in developing alternatives.

2.3.1 Source Control

General response actions for source control (soil/sediment treatment) at the Ash Landfill can be divided into the following groups:

- no-action
- institutional controls
- containment
- in situ treatment
- removal
- ex situ treatment
- disposal

2.3.2 Migration Control

General response actions for migration control (groundwater treatment) at the Ash Landfill can be divided into the following groups:

- no-action
- institutional controls
- containment
- diversion
- collection and removal
- in situ treatment
- on site (ex situ) treatment
- off-site treatment

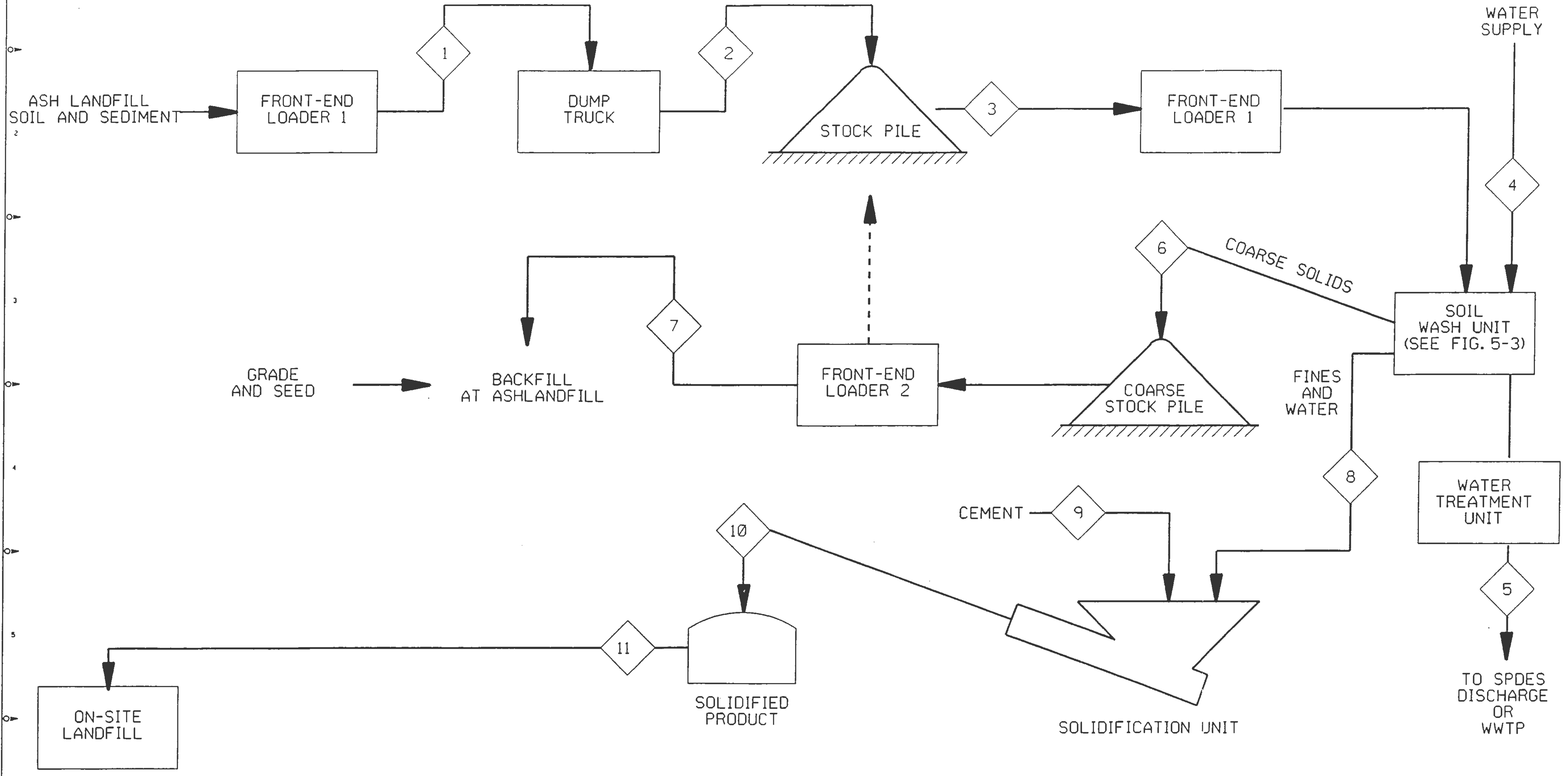
2.4 ESTIMATE OF QUANTITIES TO BE REMEDIATED

2.4.1 Soil and Sediment

Four operable units at the Ash Landfill area were evaluated under the Action Memorandum, Ash Landfill Removal Action (ES May 1994) and developed as part of the non-time critical removal action. This information has been incorporated as part of this feasibility study. Volume estimates for soil removal and treatment were developed utilizing data summarized in the Remedial Investigation Report (ES July 1994). Each area was assigned a case number and non-carcinogenic and cancer risks values were re-calculated for each removal scenario by removing the data within the remediation area from the database and re-running the risk calculations. This provides a quantifiable basis for evaluating the benefits from performing a remedial action.

The areas proposed for remediation of soil (as well as the areas already remediated during the removal action) are shown in Figures 2-1 and 2-2, and are summarized in Tables 2-7 through 2-9. Four cases (scenarios) are indicated, each of which includes the remedies already achieved under the previous cases. Case 1, the non-time critical removal action was completed, and cases 2, 3, and 4 are proposed.

As part of Case 1 the removal action, soil from Areas A and B near the "Bend in the Road" was removed and treated for volatile organics (Figure 2-1). Approximately 23,000 cubic yards were



TYPICAL FLOW RATES

MATERIAL	STREAM NO.										
	1	2	3	4	5	6	7	8	9	10	11
SOIL/SEDIMENT (CY/HR)	25	25	17	-	-	12	12	5	-	-	
WATER (GPM)				40	30						
CEMENT (CY/HR) -ASSUMED									3		
SOLIDIFIED PRODUCT (CY/HR)										8	8

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CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING
NO. 720447-03000

FIGURE 5-1
ALTERNATIVE SC-4
SOIL WASH/FINES SOLIDIFICATION
PROCESS FLOW SCHEMATIC

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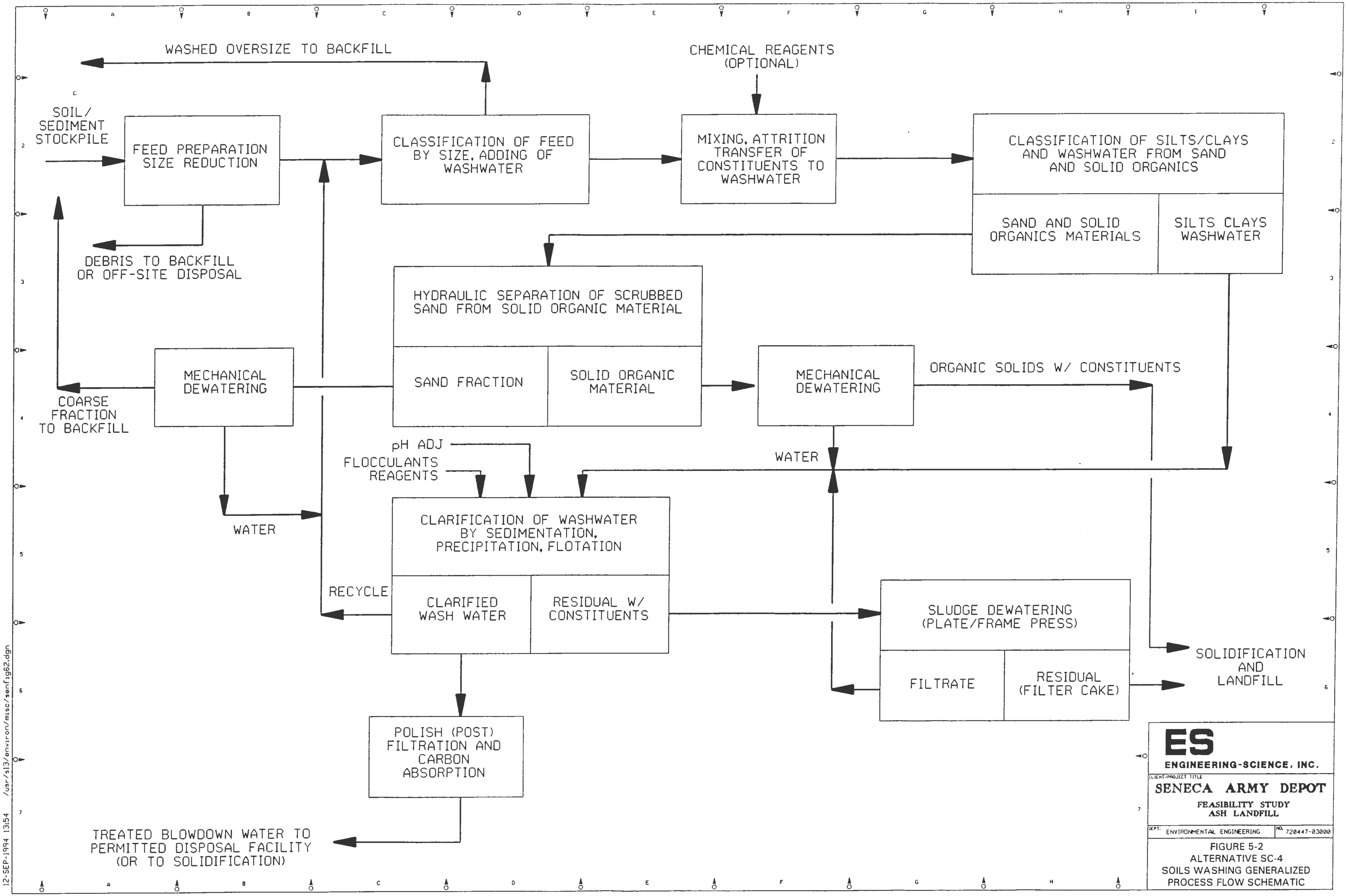

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CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING
NO. 720447-03000

FIGURE 5-2
ALTERNATIVE SC-4
SOILS WASHING GENERALIZED
PROCESS FLOW SCHEMATIC

has a height of 50 feet. The unit requires a 600-KW, 440-Volt AC power supply, and a 25 gpm water source.

The coarse fraction is removed from the unit, allowed to dry, and stockpiled in a clean soil area. The material can be tested to ensure that the hazardous constituents have been removed to acceptable levels. The material would then be re-used as clean fill.

After dewatering, the fine material will be solidified and disposed of on-site. The solidification would be accomplished on site, as described in previously. The water would be treated on-site or sent to the Depot POTW for treatment. The cost estimate assumes that the water can be treated at the Depot POTW at minimal cost.

5.2.4.2 Protectiveness

An evaluation of the criterion of Protectiveness must address several issues. The short- and long-term protectiveness to both human health and the environment must be considered. The following discussion will show how this alternative meets these criteria.

Short-term Protectiveness

Several items are included in an assessment of the short-term protectiveness of Alternative SC-4. The first issue is protection of the community during the remedial action.

There is also little threat from dust released during the excavation. The site is located approximately 750 feet from the SEDA boundary and the nearest residence is approximately 2500 feet from the site so the likelihood of any hazardous dust migrating offsite is negligible although particulate material monitoring will be included as part of the monitoring program. As discussed in Section 5.0 of the RI report, fugitive dust migration is not a major migration pathway.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during excavation are direct contact with the affected soil and inhalation of vapors or particulates. There is also potential for exposure to soils and other hazardous materials during the soil washing process. Protection from exposure can be maximized through site access controls and the use of proper protective equipment for site workers, such as dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the

site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site. All of the contractor personnel working around the soil washing unit will be trained in the proper health and safety procedures to be used near the unit.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. For Alternative SC-4, there will be few environmental impacts. There is the potential for spills during excavation, but the soil is a solid, and spills would readily be contained. There is also a potential for releases of washwater from the soil washing unit. This threat is minimized with proper controls and inspections of the units. The site workers will be trained in the proper operation of the unit operations.

The last item to be considered is the time until treatment is accomplished. This alternative should require three to six months to complete. Mobilization would take two weeks. It would take an additional three weeks to fine tune the unit. Once the unit is fully operational at 25 tph, it would take one to three months to complete the soil washing step. Backfilling of the coarse fraction, solidification of the fines onsite, backfilling of the fines, capping and demobilization would be expected to take another two to four weeks.

Long-term Protectiveness

The assessment of the long-term protectiveness of Alternative SC-4 can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the treatment technology and the materials solidified.

The magnitude of the residual risk has been quantified during the baseline risk assessment and from considering the effects of remediating various areas of the site. The soils currently demonstrates a hazard index less than the EPA target value of 1 for the noncarcinogenic risk and from the standpoint of non-carcinogenic risk, there is no need to do anything. Following implementation of this alternative, the carcinogenic risk will be lower than the target value of 1.0×10^{-4} and therefore there is no requirement to reduce the risk further. This alternative also protects against ingestion of and direct contact with soils having concentrations of lead above 500 mg/kg, and prevents potential leaching of lead into the groundwater by removing soil with concentrations of lead above 500 mg/kg.

Since residual materials will remain on the site, long-term maintenance will likely be required. Any exposed or eroded areas will be regraded to minimize erosion potential. Any areas in which soil was removed below grade will be backfilled with clean soil. A cover of native vegetation

will be established as an additional erosion control measure. The only treatment residuals remaining on site will be the coarse fraction of the soil, which will have been tested to ensure that there are no unacceptable levels of potentially hazardous constituents remaining and the solidified fine fraction. Initially, some maintenance will be required to reestablish a vegetative cover at the site. Once the cover is established, the need for long-term maintenance will only include an occasional inspection or mowing.

5.2.4.3 Reductions

Alternative SC-4 would be very effective in reducing the toxicity, mobility, and volume of the hazardous constituents present at the site. The primary goal of soil washing is volume reduction, and the process is expected to reduce the volume of contaminated soil to approximately 30 percent of the original volume. The toxicity and mobility reductions are accomplished in the solidification process. The potentially hazardous constituents are stabilized in the process, which reduces the toxicity. The solidification and subsequent backfilling of the soil fines reduces the mobility. The final mobility of the hazardous constituents is negligible.

5.2.4.4 Permanence

The permanence of the alternative must also be assessed. Once the soil fines are solidified, the remedial action would be considered permanent.

5.2.4.5 Compliance with ARARs

Alternative SC-4 will comply with all ARARs. A summary of ARAR compliance for this site is in Appendix C.

5.2.4.6 Implementability

A discussion of implementability can be divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

Technical Feasibility

The technical feasibility of Alternative SC-4 is good. Soil washing has been used for a number of years, and has been demonstrated to be effective at sites with similar contamination. Solidification/stabilization, treatability studies will be necessary to confirm that the technology will be effective at the Ash Landfill. Large landfill debris cannot be processed by the soil washing facility, instead a debris washing system will be required. The solidification/stabilization process is known to be effective for treating the soil washing residuals. The technical advantages of soil washing is to decrease the quantity of material that will require solidification. The solidification process will also be more effective because the cement matrix will solidify easier with a matrix of fines. Metals which exist at the site will become concentrated in the fines but will be chemically and physically bound in the cement matrix, making leaching or erosion as particles off-site improbable.

The excavation portion of the remediation can also be readily implemented. The areas demonstrating elevated concentrations of pollutants have been delineated, and the excavation plan will ensure that all of the spots are removed. It is possible that some minor weather delays may be encountered, but most of the soil to be removed is located in shallow depths, and should not be adversely affected by wet conditions.

Another aspect of technical feasibility is the ease with which additional work may be conducted. At this time, it is anticipated that this remedial action will preclude the necessity of any additional remedial efforts at the Ash Landfill. However, if additional work is required in the future, this remedial action will not interfere in any way. Once the remedial action is complete, the site will be revegetated, and will essentially remain as it is now.

Administrative Feasibility

The administrative feasibility of this alternative is as good or better than the rest of the alternatives. This option greatly reduces the volume of material to be solidified. Construction permits necessary for the activities are readily attainable.

Coordination with the various regulatory agencies is also important. The Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

Availability of Services and Materials

There is good availability of the materials and services necessary to accomplish this alternative. Several companies have extensive experience in implementing soil washing. These companies can rapidly assemble the necessary unit operations for the Ash Landfill.

5.2.4.7 Cost

Capital Costs

There are four major cost items for this alternative, excavation and backfilling, soil washing, solidification, and capping. Soil washing costs including excavation and backfilling are estimated to be $300 per cubic yard ($90 per ton). Solidification costs are estimated to be $150 per cubic yard ($100 per ton), and onsite capping costs would be $10 per cubic yard ($7 per ton). The total cost including engineering, oversight, and site restoration for remediation of 68,000 cubic yards (35,000 tons) is $31.5 million which includes a 20% contingency fee. The costs for this alternative is provided in Appendix D.

O & M Costs

The 30 year present worth O & M costs associated with Alternative SC-4 include cap maintenance, quarterly monitoring of groundwater and administrative costs. These costs are estimated to be $490,000.

Present Worth Costs

The present worth costs for Alternative SC-4 were calculated assuming a 10% interest rate and a 30 year monitoring and maintenance program. The total present worth cost for this alternative is estimated to be $32 million.

5.2.5 Analysis of Alternative SC-5; Excavation of Debris Piles/Off-site Subtitle D Landfill, Cover Ash Landfill and NCFL

5.2.5.1 Definition of Alternative SC-5

This option consists of the excavation of the Debris Piles and installing a vegetative soil cover for the Ash Landfill and the NCFL. The Debris Piles would be transported to an off-site,

Subtitle D, solid waste landfill. A Subtitle D Landfill refers to a solid waste landfill that meets the NYSDEC and USEPA Subtitle D landfill construction specifications. The Debris Piles are small well defined areas within the Ash Landfill Site. The RI identified three distinct debris piles, designated Debris Piles A, B and C. The total volume is estimated to be 770 cubic yards of material. The sampling results showed that these piles contain some of the highest levels of lead (several samples exceed 500 ppm) and if left on-site may not be protective of human health and the environment over a long period of time even though the BRA indicate that the site risks were acceptable for current and future scenarios. The Ash Landfill and the NCFL would be covered in place using a 9" layer of compacted fill and a vegetative cover. The work would be completed using standard construction equipment. The Debris Piles are expected to meet the requirement for disposal in a non-hazardous, Subtitle D, solid waste landfill in the State of New York. Two potential landfills are the Seneca Meadows Landfill in Waterloo, NY and the New York High Areas Landfill in Fairport, Monroe County.

Process Flow and Site Layout

The process for this alternative would be the same as that described in Alternative SC-3.

5.2.5.2 Protectiveness

The short and long term protectiveness to both human health and the environment have been considered. The following discussion describes how this alternative meets these criteria.

Short-term Protectiveness

The short-term protectiveness for this alternative is considered to be the same as that described in Alternative SC-3, but somewhat higher since less soil will be excavated and therefore the potential exposures to on-site workers would be less.

Long-term Protectiveness

The long-term protectiveness for this alternative is considered to be the same as that described in Alternative SC-3, with the exception that the long-term protectiveness would be somewhat greater because of the off-site disposal of the Debris Piles.

5.2.5.3 Reduction

This alternative provides reduction in mobility by providing a vegetative soil cover for the Ash Landfill and the NCFL areas and by removing the Debris Piles.

5.2.5.4 Permanence

The permanence of this alternative is considered to be the same as SC-3.

5.2.5.5 Compliance with ARARs

Alternative SC-5 will comply with all ARARs. A list of ARARs for this alternative is in Appendix C.

5.2.5.6 Implementability

The technical, administrative, and availability of services and materials for this alternative is considered to be the same as Alternative SC-3.

5.2.5.7 Cost

Capital Costs

The estimated capital cost for this alternative is $237,063. The basis for this cost is provided in Appendix D. This cost was the next lowest capital cost after the no-action alternative.

O&M Costs

The present worth O&M costs for this alternative ($490,000) are considered to be the same as Alternative SC-3. However, the expected O&M costs for maintaining a vegetative soil cover may be less than the actual costs to maintain a clay cap which is the remedial alternative presented in SC-3.

Present Worth Costs

The present worth costs for this alternative are estimated to be $727,063. This assumes that O&M will be provided for 30 years at an interest rate of 10%. This total cost is the next lowest of the source control alternatives considered after the no-action alternative.

5.3 COMPARATIVE ANALYSIS OF SOURCE CONTROL ALTERNATIVES

5.3.1 Introduction

The purpose of this section is to compare each of the Source Control alternatives with respect to the specific evaluation criteria. The following discussion will rate each of the alternatives with regard to the evaluation criteria and identify the relative advantages and disadvantages of each. This comparison will provide the information necessary to select the most appropriate remedial alternative for this site.

The discussion is divided into two groups. The first group, the threshold criteria, include the overall protection of human health and the environment and includes compliance with ARARs. The next group considers the remainder of the evaluation criteria: long term effectiveness and permanence, reduction of toxicity, mobility, and volume through treatment, short-term effectiveness, implementability, and cost. Table 5-1 presents a summary of the analysis of each alternative in terms of the criteria.

5.3.2 Threshold Criteria

The first two criteria are overall protection of human health and the environment and compliance with ARARs. These are called threshold criteria because each alternative must meet these in order to be carried through the process. Alternatives which do not meet these criteria were eliminated prior to the detailed analysis of alternatives.

5.3.3 Other Considerations

5.3.3.1 Long Term Effectiveness and Permanence

The criterion of long-term effectiveness addresses the long-term protectiveness to human health and the environment. Most of the detailed alternatives are highly effective in eliminating the

Table 5-1
Individual Evaluation of Source Control Alternatives

Criteria	Alternative SC-1 No Action	Alternative SC-2 Excavation/ Off-site Disposal	Alternative SC-3 Excavation/ Consolidation/Cap	Alternative SC-4 Excavation/Soil Washing/ Backfill/Solidify/Cap	Alternative SC-5 Excavation/Soil Washing/ Backfill/Solidify/Cap
OVERALL PROTECTIVENESS					
Human Health Protection - Direct Contact/Soil Ingestion	Risk for current and future land use is 1 x 10E-4 HI = 0.24	Risk for current and future land use is 2 x 10E-5 HI = 0.19	Risk for current and future land use is 2 x 10E-5 HI = 0.19	Risk for current and future land use is 2 x 10E-5 HI = 0.19	Risk for current and future land use is 2 x 10E-5 HI = 0.19
- Removal of soils with lead concentrations >500 mg/kg	Soils with lead concs. >500 mg/kg remain	Soils with lead concs. >500 mg/kg removed	Soils with lead concs. >500 mg/kg removed	Soils with lead concs. >500 mg/kg removed	Soils with lead concs. >500 mg/kg removed
Environmental Protection	Protects environment	Protects environment	Protects environment	Protects environment	Protects environment
COMPLIANCE WITH ARARs	No promulgated soil standards	Will comply with all ARARs	Will comply with all ARARs	Will comply with all ARARs	Will comply with all ARARs
LONG-TERM EFFECTIVENESS AND PERMANENCE					
Magnitude of Residual Risk	Sources have not been removed. Existing risk will remain.	No residuals will remain on-site.	Risk eliminated as long as cap maintained.	Residuals will remain on-site. Erosion control necessary.	Residuals will remain on-site. Erosion control necessary.
Permanence	Not a permanent solution.	Once soils removed from site, remedial action considered permanent.	Once soils are consolidated and isolated under cap, remedial action considered permanent.	Once soil fines are solidified, remedial action considered permanent.	Once soils removed from site, and isolated under cov remedial action considered permanent.

Table 5-1
Individual Evaluation of Source Control Alternatives

Criteria	Alternative SC-1 No Action	Alternative SC-2 Excavation/ Off-site Disposal	Alternative SC-3 Excavation/ Consolidation/Cap	Alternative SC-4 Excavation/Soil Washing/ Backfill/Solidify/Cap	Alternative SC-5 Excavation/Soil Washing/ Backfill/Solidify/Cap
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT					
Reduction of Toxicity, Mobility, or Volume	None. Some degradation due to natural attenuation.	Mobility reduced by landfilling.	Very effective in reducing mobility of constituents.	Very effective in reducing volume. Solidification reduces toxcity and mobility.	Mobility reduced by landfilling.
SHORT-TERM EFFECTIVENESS					
Community Protection	Risk to community not increased by remedy implementation.	Temporary increase in dust production during excavation. Also transport of materials off-site.	Temporary increase in dust production during excavation.	Temporary increase in dust production during excavation.	Temporary increase in dust production during excavation.
Worker Protection	No significant risk to workers.	Protection required against dermal contact and inhalationof contaminated dust during excavation and cap construction. construction.	Protection required against dermal contact and inhalationof contaminated dust during excavation and cap construction. construction.	Protection required against dermal contact and inhalationof contaminated dust during excavation and cap construction. construction.	Protection required against dermal contact and inhalationof contaminated dust during excavation and cap construction. construction.
Environmental Impacts	Continued impacts from existing conditions	Little or no environmental impacts.	Little or no environmental impacts.	Potential for spills during excavation and soil washing.	Little or no environmental impacts.
Time Until Action is Complete	Not applicable	One to two months.	One to two months.	Three to six months.	One to two months.

Table 5-1
Individual Evaluation of Source Control Alternatives

Criteria	Alternative SC-1 No Action	Alternative SC-2 Excavation/ Off-site Disposal	Alternative SC-3 Excavation/ Consolidation/Cap	Alternative SC-4 Excavation/Soil Washing/ Backfill/Solidify/Cap	Alternative SC-5 Excavation/Soil Washing/ Backfill/Solidify/Cap
IMPELEMETABILITY					
Technical Feasibility	No construction or other activities.	Standard excavation equipment.	Simple to construct and operate.	Soil washing and solidification have been demonstrated to be effective.	Standard excavation equipment.
Ease of Doing More Action if Needed	If monitoring indicates more action is necessary, may need to go through FS/ROD process again.	Not interfere.	Not interfere.	Not interfere.	Not interfere.
Ability to Obtain Approvals and Coordinates with Other Agencies	No approval necessary	Should be easy to obtain permits.	Should be easy to obtain permits.	Should be easy to obtain construction permits.	Should be easy to obtain permits.
Availablility of Services and Materials	No services or capacities required	Subtitle D landfills located nearby.	Materials and equipment locally available.	Several companies have experience in soil washing.	Subtitle D landfills located nearby.
COST					
Capital Cost	$0	$17,500,000	$1,370,000	$31,500,000	$237,063
Annual O&M Cost	$0	$0	$490,000	$490,000	$490,000
Present Worth Cost	$0	$17,500,000	$1,860,000	$32,000,000	$727,063

long-term threats. The results of the BRA indicate that for current and intended future use of this site, the risks are within the EPA target range for carcinogenic risks and below the acceptable target value for non-carcinogenic risks, especially now that the VOCs were eliminated from the soils at the "Bend in the Road" during the non-time critical removal action. Consequently, there is no requirement to perform a risk-based remedial action since current site conditions are protective of human health. The environmental risk assessment did not identify unacceptable ecological risk and, therefore, current and intended future use of this site is also protective of the environment. However, the site-specific clean-up goal for lead in soil is not achieved by Alternative SC-1, the No Action Alternative. Alternative SC-4, in which the hazardous constituents are washed and solidified ranks high for long-term effectiveness because of the effectiveness of the solidification process. Alternatives SC-2, excavation and off-site disposal, and SC-3 and SC-5 excavation/ consolidation and capping, were not ranked high for long-term effectiveness because no treatment is performed. Alternative SC-1, the no action alternative, provides the least amount of long-term protection of human health and the environment because the dermal contact and ingestion of leaching of metals and PAHs will continue.

The rankings of the alternatives based on permanence are based upon the concept that those alternatives that reduce the overall site risk are ranked higher than those that do not. All of the alternatives that provide treatment are essentially permanent once the remedial action objectives have been obtained. Once the objectives have been met and the risk has been reduced to within acceptable criteria, there is no need to continue operation of the treatment program. Alternative SC-4 is considered to be the most permanent because this alternative involves treatment by soil washing and solidification. Alternative SC-3, the consolidation and capping alternative does not score as well since some soil containing hazardous constituents will remain on site. Alternative SC-5 was ranked the same as SC-3. Alternative SC-2 also does not score as well as Alternative SC-4 because Alternative SC-2 involves landfilling. Alternative SC-1, the no action alternative is not permanent since no treatment is taking place.

5.3.3.2 Reductions

Source control alternatives have been compared relative to the decreases in the toxicity, mobility, and volume of the hazardous constituents present at the site.

Alternative SC-4 yields the greatest reduction in the toxicity by separating the fines and solidifying this smaller volume of material. Alternative SC-4 has advantages because hazardous constituents are normally concentrated in the fines fraction of the soil to be treated. The solidification process is more effective for fines than large aggregate materials and is most

effective for metals and low concentrations of semi-volatile organic matrices. The solidification/stabilization process decreases the toxicity of the metals because the metals are converted to less soluble forms. Alternatives SC-2, SC-3 and SC-5 do not score as well because both alternatives do not involve any treatment to reduce toxicity. However, these alternatives involve placing the soils in landfills, which consolidates the toxic materials and eliminates the exposure pathways. Alternative SC-1, the no action alternative does not reduce the toxicity of the hazardous constituents.

Alternative SC-4 provides the best reduction in mobility. Once the soils are washed, solidified and backfilled, the hazardous constituents are essentially immobile. In this option, the bulk of the contaminated soil is treated and backfilled, which immobilizes the hazardous constituents. In this alternative, some of the soil is left (or replaced) at the site, so there is a slight potential for mobility associated with this alternative. Alternative SC-3 will reduce the mobility by capping the landfill which will prevent leaching of contaminants from the landfill area. Alternative SC-2 reduces mobility by disposing of material in an off-site landfill, however, these materials may migrate from the off-site landfill and cause impacts at another location. Alternative SC-1, the no action alternative does nothing to reduce the mobility of the hazardous constituents and was ranked low. Alternative SC-5 received the same score as SC-3.

Alternative SC-4 provides the greatest volume reduction of the contaminated soils. For SC-4, the hazardous constituents are concentrated in the fines fraction, which reduces the volume of the contaminated soil to approximately 30 percent of the original volume. The soil is then solidified, which will cause some increase in volume but overall the volume of hazardous constituents in soil is reduced. Alternatives SC-2, SC-3 and SC-5 rank lower because these alternatives do not provide volume reduction. Rather, the soils which are excavated and landfilled will increase in volume by approximately 20% as a result of the excavation process. In Alternative SC-1, the no action alternative, there is slight volume decrease due to natural processes.

5.3.3.3 Short-term Effectiveness

Alternative SC-1, the no action alternative provides good short-term protection of human health and the environment because of the administrative and land use controls currently in place. The remaining three alternatives involve excavating the soils, which would lower short-term protection to workers. Therefore, Alternatives SC-2, SC-3, SC-4 and SC-5 are ranked lower than SC-1. Alternative SC-3 and SC-5 were ranked below SC-1 because these alternatives involve limited excavation. Alternative SC-2 was ranked next because the alternative involves excavation and off-site transportation of contaminated soil. The soil washing alternative, SC-4 rated **lowest** for

short-term effectiveness because it involves handling of a large volume the contaminated soil, and large quantities of treatment residuals will be generated, such as spent wash water which must also be treated.

5.3.3.4 Implementability

The alternatives carried to the detailed analysis score high on implementability. For technical feasibility, alternative SC-1, (the no action alternative) scored the highest. Alternative SC-3 and SC-5 involve standard earth moving equipment. Alternative SC-2 was ranked lower than SC-3 because of the transport of hazardous materials off site. Alternative SC-4 is the hardest to implement because of the need for specialized soil washing equipment, however, enough soil washing vendors are available to ensure that this option is still viable.

Alternative SC-1, scored well on long term monitoring, since there will be no long term monitoring required. Alternative SC-2 was ranked well because the long-term monitoring will be the responsibility of the off-site landfill operator. Alternatives SC-3 and SC-5 which includes construction of a cap or cone require long-term groundwater monitoring. Alternative SC-4 will likely require long-term monitoring, although the amount of monitoring will be less than SC-3 since there has been a large decrease in the volume of material under consideration. Alternative SC-3 and SC-5 would also require long term maintenance of the impermeable cap.

The availability of the equipment, materials, and vendors is very good for all the alternatives. Alternative SC-4 scores the lowest because there are fewer soil washing vendors than there are excavation and capping vendors; however, this will not preclude implementation of this alternative. Alternatives SC-2, SC-3 and SC-5 rates the best on availability, because these materials are more readily available from local suppliers than the other alternatives.

The last item to consider is agency approval. Alternative SC-1, the no action alternative is ranked lowest because of the impacts to groundwater. Alternatives SC-2 and SC-3 also rank low because Alternative SC-2 involves the transfer of all the waste to an off-site landfill, which is generally discouraged by the EPA, and SC-3 utilizes a cap technology which is considered to be a temporary solution by the EPA. Alternative SC-4 is the best because of the greatest volume reduction and the permanent destruction of pollutants. Alternative SC-5 received a higher score because it complies with ARARs and is cost-effective.

5.3.4 Cost

The last criterion to compare is cost. This comparison will evaluate the present worth costs of the alternatives, which are presented in Table 3-5.

The least expensive alternative is SC-1, the no action alternative, which has no costs associated with it. SC-5 is the next least expensive alternative because it requires only limited off-site disposal and a simple soil cover. SC-3 is the next least expensive alternative because it involves excavation and clay capping with no off-site disposal. This can all be performed by local contractors with local materials. The most expensive alternative is the soil washing alternative SC-4 because it requires mobilization of specialized equipment and will also involve performing treatability studies. Although SC-4 has the highest present worth costs, it also provides the greatest reduction in the toxicity.

5.3.5 CONCLUSIONS FOR SOURCE CONTROL

The Baseline human health risk assessment indicates that under the current and future use of the site, the risk-based carcinogenic and noncarcinogenic human health risk values are within the EPA target ranges. Therefore if risk-based health criteria are applied to the Ash Landfill, remedial objectives have been met with no further action. However, soils at the site have lead concentrations above the established clean-up goal of 500 mg/kg.

Alternatives SC-2, 3, 4 and 5 were determined to meet the site specific remedial objectives for soil. That is, they are protective against dermal contact with and ingestion of soils in the debris piles and the landfills.

Alternative SC-5 received the highest overall score due to its low costs, protectiveness of human health and the environment, implementability and availability.

Alternative SC-4 ranks highest for long-term protectiveness of human health and the environment, permanence, and reductions in toxicity, mobility, and volume of hazardous constituents. Alternative SC-2, which involves off-site disposal of the materials, ranks lowest for short-term protectiveness because all of the excavated soil are transported off-site for disposal. Alternative SC-3 ranks next highest for costs because the present worth cost of this alternative is $1,860,000, which is the lowest cost of the remaining alternatives involving remedial actions.

5.4 DETAILED ANALYSIS OF MIGRATION CONTROL (MC) ALTERNATIVES

5.4.1 Analysis of Alternative MC-2: Natural Attenuation of Plume/Institutional Controls

5.4.1.1 Definition of Alternative MC-2

The natural attenuation/institutional control alternative means that no migration control remedial activities will be undertaken at the site other than institutional controls. Natural attenuation of the groundwater plume will be the only treatment. Current monitoring activities include quarterly monitoring of over 30 wells in place at the site which will continue under this alternative. Current security measures include the SEDA-wide security activities which effectively eliminate public access to the area.

An extensive groundwater monitoring program will be performed to ensure that the natural attenuation process is occurring and to assure that the migration of the constituents of concern does not increase, particularly in the direction of the farmhouse west of the site. The groundwater monitoring program for this alternative will be conducted for 30 years and will include the annual sampling of at least seven monitoring wells associated with the plume. These monitoring wells include one monitoring well located upgradient of the plume, three plume wells located within the boundary of the plume and along a line parallel to the direction of groundwater flow, and three point of action wells located at the Ash Landfill boundary along the downgradient edge of the plume. The three point of action wells will be monitored to determine if there is a statistically significant upward or downward tend in the concentration of the constituents of concern. If the data from these wells indicate an upward trend, a contingency plan will be implemented. Several wells which may be used for this long-term monitoring program already exist at the site. The three point of action wells will be installed as part of this alternative.

The contingency plan would consist of applying a deed restriction to the parcel of land owned by the Army to indicate that no groundwater wells may be used for drinking water and that no drinking water wells should be constructed on-site, and supplying an alternative water supply to the off-site residences. The alternative water supply would consist of extending the SEDA 6-inch water main that exists on the Ash Landfill site along West Smith Farm Road to provide water to the necessary residences.

This alternative will be used as a baseline for comparison with all of the other alternatives developed as part of this feasibility study.

Natural Attenuation

The groundwater at the Ash Landfill has been impacted by the VOCs trichloroethene (TCE), and the anaerobic breakdown products which include 1,2-dichloroethene (1,2-DCE) and vinyl chloride. The full extent of the plume was delineated as part of the RI for the Ash Landfill in 1994. The westernmost tip of the plume was shown to extend approximately 100 feet beyond the SEDA boundary. Although the plume has not impacted any source of drinking water, three farmhouse wells are located approximately 1250 feet from the leading edge of the plume at the nearby farmhouse residence located on Old Smith Farm Road. One well draws water from the till/weathered shale aquifer.

In 1994, the source area of the plume was decontaminated and several thousand gallons of groundwater from the area were extracted and treated from the till/weathered shale aquifer. The purpose of this remedial action was to eliminate the continued mass input to the groundwater system.

Historical data collected as part of the quarterly monitoring program from the Ash Landfill support the theory that natural attenuation of the chlorinated VOCs in the groundwater is occurring. Results from the groundwater modeling study conducted for the Ash Landfill indicate the time in which the concentrations of total VOCs on-site will be reduced below ARARs and the concentrations of VOCs in the plume off-site.

Various patterns have been traced for the three constituents of concern at the Ash Landfill from groundwater sampling data in various monitoring wells at the site. The patterns include:

> The total concentration of the constituents of concern in the plume decreases with increasing distance from the source area.
>
> The direction of plume travel is consistent with the movement of groundwater.
>
> The ratio of TCE to the breakdown products changes as the distance from the source area increase.

Historical data for 1,2-DCE was inconsistent and not comparable throughout the entire data set. Vinyl chloride was not plotted because it was detected in only a few instances and in a limited number of wells.

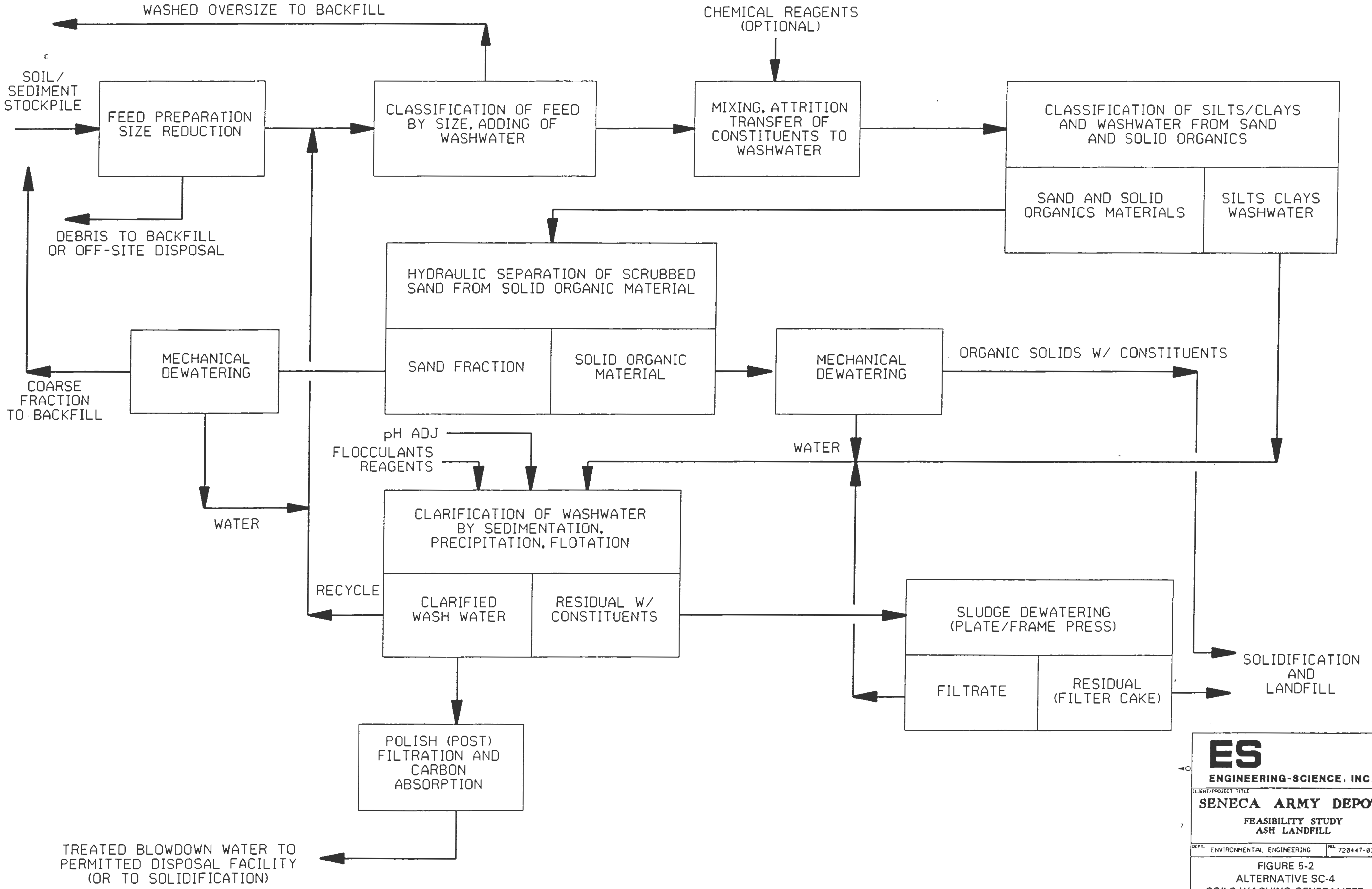
On the basis of the historical data, no wells show a consistent increase in VOC concentration over time, which would be indicative of continued movement of the VOC plume. Most of the data from the wells indicate that the concentrations are remaining the same over the 6 to 9 years of monitoring, and in some instances they appear to be deceasing.

Groundwater Modeling Study

The Groundwater Modeling Study conducted for the Ash Landfill is presented in Appendix F of this report. The purpose of the Groundwater Modeling Study was to evaluate the ability of the natural system to degrade the remaining plume. More specifically, the Groundwater Modeling Study was utilized to predict the future migration of the plume of VOCs and to evaluate the positive effect that eliminating the source of VOCs will have on the future migration of the plume. The goal of the modeling was to evaluate the potential for future impacts to off-site farmhouse wells by VOCs migrating from the Ash Landfill under pre-and post-VOC source removal scenarios. If the results of this evaluation suggested that the existing conditions were favorable for the degradation process, then this alternative, natural attenuation with institutional controls would be the preferred remedial action alternative. This approach was deemed appropriate because source control was accomplished in the spring of 1995 and was successful in eliminating continued leaching of the constituents of concern to the groundwater system.

For this groundwater study, numerical groundwater flow and transport models were selected as the preferred approach to evaluate site conditions. The USGS groundwater flow model, MODFLOW, and the three dimensional transport model, MT3D, were selected as the mechanism to predict the future migration of the plume relative to its current configuration. The transport model was used to simulate the effect of eliminating the source material on future migration of the plume.

The flow of groundwater at the Ash Landfill occurs primarily through two hydrostratigraphic units: a till/weathered shale unit and an competent shale unit. At the Ash Landfill the groundwater flow direction in both the till/weathered shale and competent shale units is consistently to the west toward Seneca Lake. The groundwater flow model consisted of a flow system defined by three model layers, layer 1 for the till/weathered shale and layers 2 and 3 for the competent shale. The MODFLOW model simulated a groundwater flow system defined by



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CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING | NO. 720447-03000

FIGURE 5-2
ALTERNATIVE SC-4
SOILS WASHING GENERALIZED
PROCESS FLOW SCHEMATIC

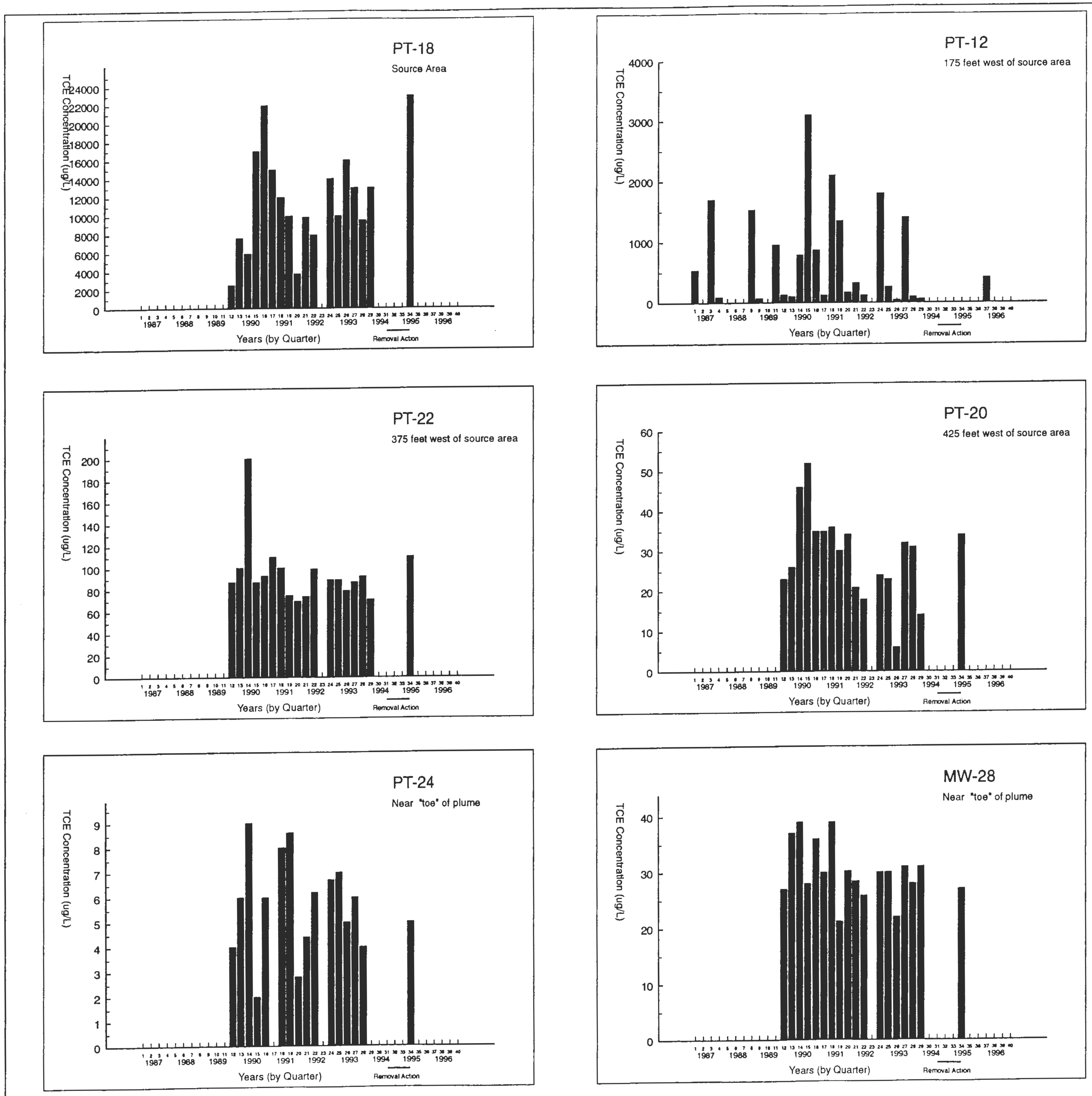

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FIGURE 5-3
HISTORICAL TCE
CONCENTRATIONS IN GROUNDWATER

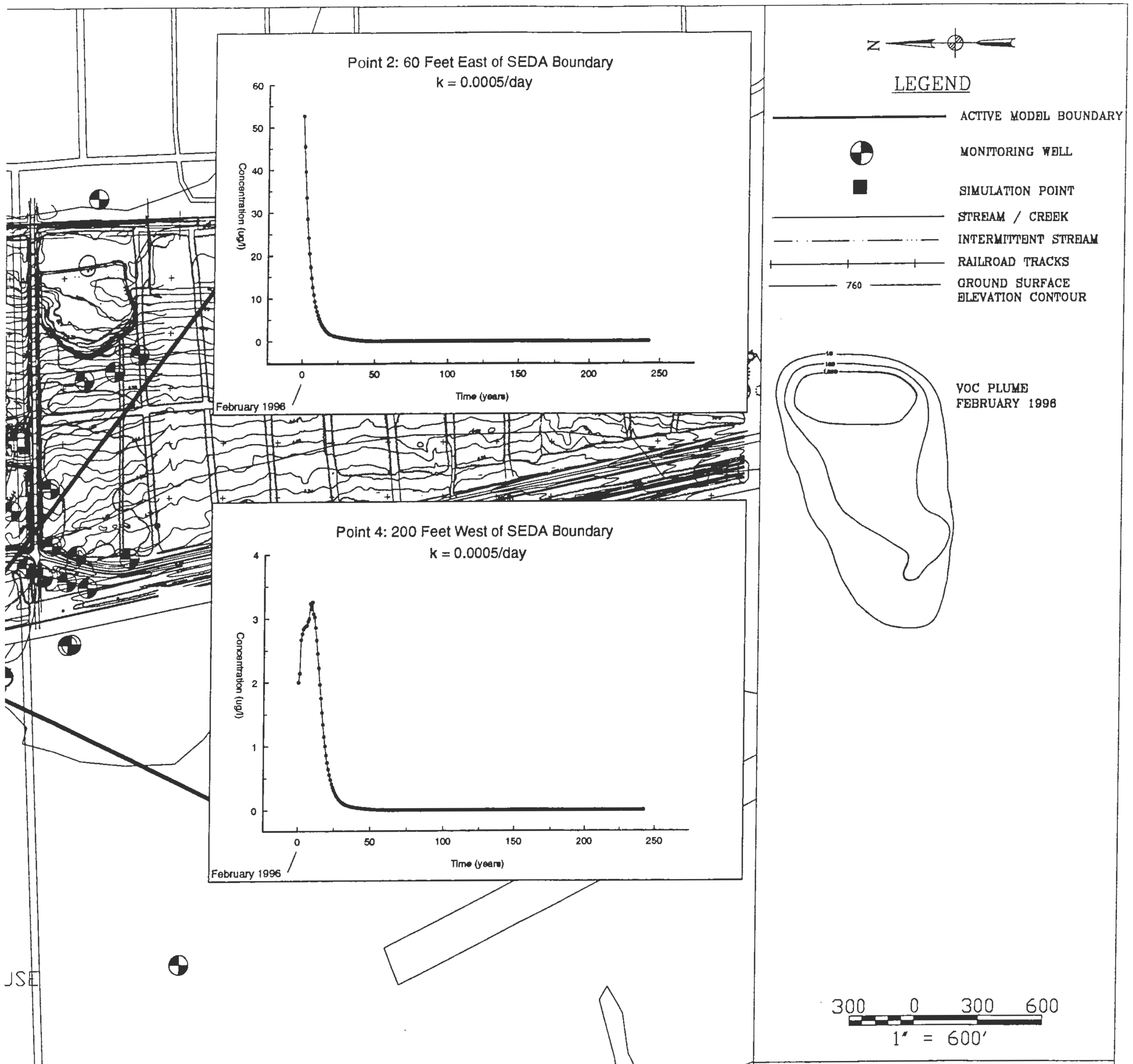
SCALE NA	DATE MAY 1996

GRAPHICS\SENECA\FS\HISTTCE.CDR

a constant head boundary at Seneca Lake, a groundwater divide no flow boundary between Seneca and Cayuga lakes, and streamline no flow boundaries along the northern and southern sides of the model. An important aspect of the groundwater flow system near the Ash Landfill is that much of the water that enters the system via precipitation is returned to the atmosphere through a combination of evapotranspiration and capillary rise in the fine-grained till. Thus, the net recharge rate was a significant factor affecting the heads calculated by the MODFLOW model.

Head and flow data from the calibrated flow model were incorporated into the MT3D contaminant transport model to simulate the migration of the VOC plume under three scenarios. Under Scenario 1 the transport model was calibrated using the existing plume as a basis of comparison. The plume was simulated from the time of the release (t = 0) to 50 years with two constant sources of VOCs in the Ash Landfill. The results indicate that the simulated concentrations in layer 1 matched the existing plume configuration at approximately 35 years after the time of the release using a conservative k value; the estimated time of release of the VOCs is between 35 and 40 years. If the released occurred before 40 years ago, a larger k would be required for calibration. VOC concentrations in layers 2 and 3 were found to be higher than those measured in nearby bedrock wells and thus the model is believed to predict higher plume concentrations than actually exist in the bedrock. Scenario 2 is an extension of Scenario 1 in which the model was run for a time frame of 100 years with the same source term as Scenario 1.

Under Scenario 3, the constant source of VOCs was removed from the model to reflect the removal action performed at the Ash Landfill in the Spring of 1995 and significantly lower initial starting concentration fields were used for this scenario than in Scenario 2. As expected, the effects of the removal action significantly reduced the size (i.e., length of the plume) and the magnitude of the concentrations in the plume over time when compared to Scenario 2. Degradation of the existing groundwater plume was likely occurring based upon the measured concentrations of breakdown products in downgradient wells. This degradation rate was quantified for use in the MT3D model to support the hypothesis that, combined with source removal, the indigenous microbial community was capable of eliminating the remaining plume prior to the plume reaching any off-site receptors(the nearest current receptor is at the farmhouse). Parsons ES was able to provide supporting information that the conditions at the site are favorable for biotic reductive dechlorination, although in some areas of the plume conditions were not as favorable as in others. The degradation rates calculated for use in the model are slow and consistent with the supporting site data.



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FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING
Dwg. No. 720447-08000

FIGURE 5-4
PROFILES OF VOC CONCENTRATIONS AT SELECTED LOCATIONS IN LAYER 1-SENARIO 3-B

SCALE 1" = 600'
DATE MAY 1996
REV A

5.4.1.2 Protectiveness

The protectiveness of this and all alternatives will be assessed with regard to short- and long-term protectiveness to both human health and the environment. The RI indicated that, in the short-term, the natural attenuation alternative is currently protective of human health. Also, the source of the VOCs in the soil was removed during the non-time critical removal action. Although there has been some migration of the groundwater plume, off-site migration has been limited. No off-site drinking water wells have been impacted. There is no current use of the shallow groundwater at the Ash Landfill, and there are no plans to use this groundwater for drinking water in the near future.

The natural attenuation alternative will provide long-term protectiveness of human health and the environment, however, there is some uncertainty associated with long term protectiveness since off-site land use cannot be controlled. The Army intends to maintain a groundwater monitoring program and ensure that public health and the environment are protected, using institutional controls if necessary. As described in the baseline risk assessment (BRA) portion of the RI report, the future long term land use of the site included a site construction worker assuming some construction activities could occur at this inactive site. If the non-time critical removal action had not been performed, the natural attenuation alternative would not have been protective of human health under this scenario. However, the removal action remediated the VOC source soils near the "Bend in the Road"; these soils were responsible for the unacceptable risk to the construction worker.

5.4.1.3 Reductions

Overtime, there would be a reduction in the VOC concentrations to below the NY State GA standards, and thus, there would be a reduction in toxicity of the impacted groundwater at the site. Natural attenuation would be expected, through dispersal of the hazardous constituents in the groundwater, and through natural biodegradation. Additionally, because the source of the VOCs in soil was eliminated during the non-time critical removal action, the volume of impacted groundwater (i.e., size of the plume) is expected to decrease over time, through dispersion and natural biodegradation, as was shown by the groundwater model (Appendix F).

5.4.1.4 Permanence

The natural attenuation alternative does provide a permanent solution over the course of time even though no treatment will occur.

5.4.1.5 Compliance with ARARs

The natural attenuation alternative does comply with chemical-specific ARARs. Over time, the concentrations of VOCs in groundwater will be reduced to below the Federal MCL or NY State GA standards. Since no action is taking place, there are no action-specific ARARs. A list of the ARARs for this alternative are in Appendix C.

5.4.1.6 Implementability

Monitoring that would monitor the concentrations of pollutants in several monitoring wells will be performed as part of a groundwater monitoring program. The groundwater use as a drinking water source will be restricted and an alternative drinking water supply will be determined. These institutional controls will eliminate exposure and, therefore, maintain acceptable risk.

5.4.1.7 Cost

The costs associated with the natural attenuation alternative include monitoring activities and providing an alternate water supply. The present worth cost of 30 years of quarterly monitoring is estimated to be $955,000.

5.4.2 Analysis of Alternative MC-3 and MC-3a: Air Sparging of Plume/Funnel-and-Gate System/Iron Filings

5.4.2.1 Definition of Alternative MC-3 and MC-3a

Alternative MC-3 involves the installation of two air sparging trenches and two vapor extraction trenches above the sparging trenches to collect the sparged volatiles. As shown in Figure 5-5, the downgradient trench would be located as close as possible to the fence which runs along the western boundary of SEDA. The other trench would be located near the former VOC source area.

The system consists of a sparging trench in the saturated soil and vapor recovery trench above the sparging trench. Horizontal piping will be used in the trench to act as air injection and vapor extraction points. Trenches are considered advantageous due to the low permeability of the native soils. The air promotes volatilization of the organic constituents in the groundwater, and also promotes aerobic biodegradation. The volatilized organics are captured by the vapor recovery wells, in much the same manner as a soil vapor extraction system. The air stream will be passed through vapor-phase carbon or some other vapor treatment technology to meet the requirements of air quality standards. Periodic groundwater monitoring would be used to assess the progress of the treatment.

5.4.1.2 Protectiveness

The protectiveness of this and all alternatives will be assessed with regard to short- and long-term protectiveness to both human health and the environment. The RI indicated that, in the short-term, the natural attenuation alternative is currently protective of human health. Also, the source of the VOCs in the soil was removed during the non-time critical removal action. Although there has been some migration of the groundwater plume, off-site migration has been limited. No off-site drinking water wells have been impacted. There is no current use of the shallow groundwater at the Ash Landfill, and there are no plans to use this groundwater for drinking water in the near future.

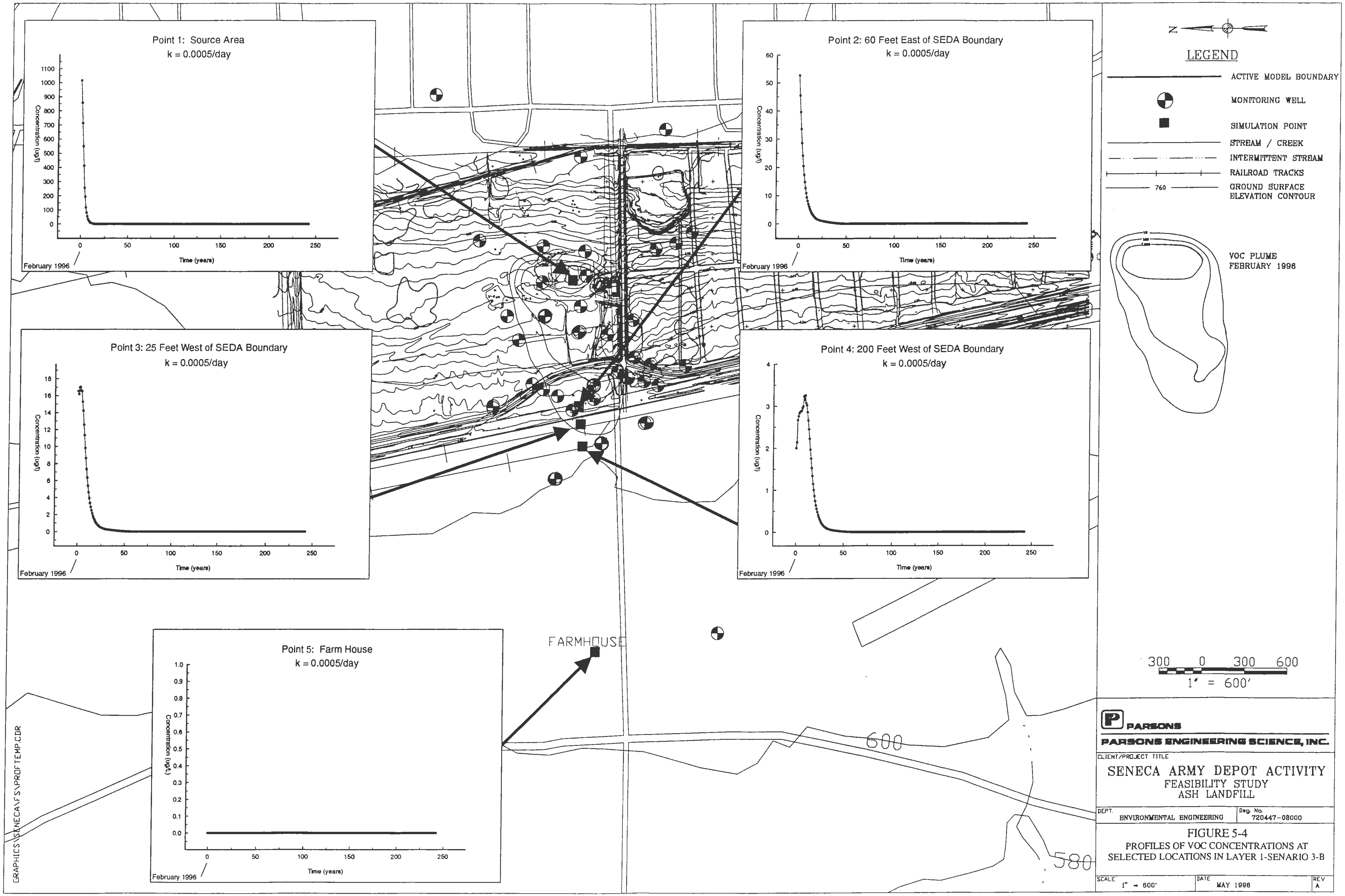
The natural attenuation alternative will provide long-term protectiveness of human health and the environment, however, there is some uncertainty associated with long term protectiveness since off-site land use cannot be controlled. The Army intends to maintain a groundwater monitoring program and ensure that public health and the environment are protected, using institutional controls if necessary. As described in the baseline risk assessment (BRA) portion of the RI report, the future long term land use of the site included a site construction worker assuming some construction activities could occur at this inactive site. If the non-time critical removal action had not been performed, the natural attenuation alternative would not have been protective of human health under this scenario. However, the removal action remediated the VOC source soils near the "Bend in the Road"; these soils were responsible for the unacceptable risk to the construction worker.

5.4.1.3 Reductions

Overtime, there would be a reduction in the VOC concentrations to below the NY State GA standards, and thus, there would be a reduction in toxicity of the impacted groundwater at the site. Natural attenuation would be expected, through dispersal of the hazardous constituents in the groundwater, and through natural biodegradation. Additionally, because the source of the VOCs in soil was eliminated during the non-time critical removal action, the volume of impacted groundwater (i.e., size of the plume) is expected to decrease over time, through dispersion and natural biodegradation, as was shown by the groundwater model (Appendix F).

5.4.1.4 Permanence

The natural attenuation alternative does provide a permanent solution over the course of time even though no treatment will occur.



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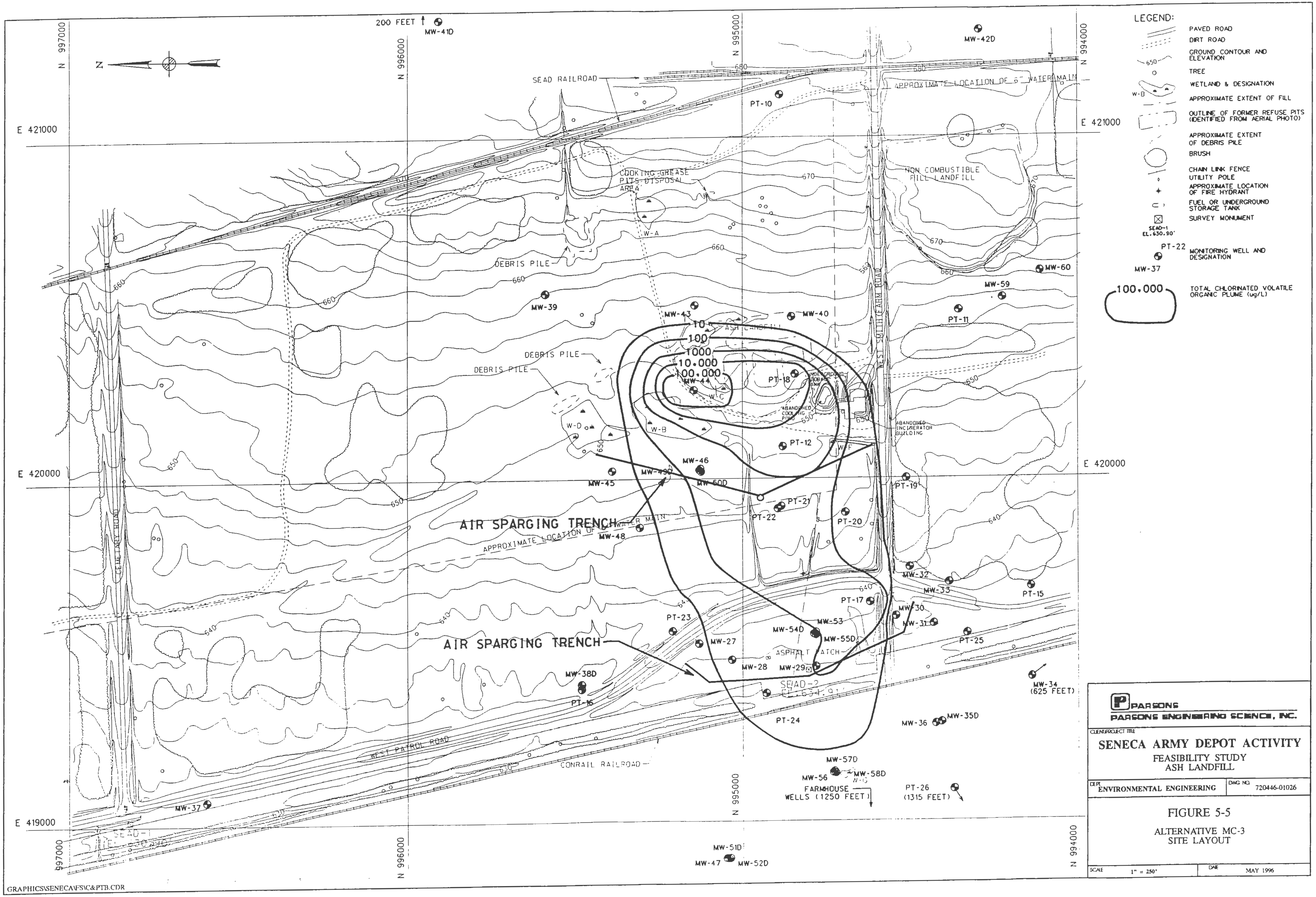
ASH LANDFILL

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	720447-08000

FIGURE 5-4
PROFILES OF VOC CONCENTRATIONS AT
SELECTED LOCATIONS IN LAYER 1-SENARIO 3-B

SCALE	DATE	REV
1" = 600'	MAY 1996	A



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FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING
DWG NO. 720446-01026

FIGURE 5-5

ALTERNATIVE MC-3
SITE LAYOUT

SCALE 1" = 250'
DATE MAY 1996

GRAPHICS\SENECA\FS\C&PTB.CDR

Alternative MC-3a would use the "funnel-and-gate" approach which is a variation of MC-3. This approach uses low permeability cut-off walls (funnel) to direct groundwater flow to a gate where the groundwater is treated using either air sparging or, alternatively, a permeable reaction bed of iron filings. The cut-off walls would be installed in the same basic configuration as the sparging trenches shown in Figure 5-5. The gates would be located at the point of convergence of the cut-off walls. The gates would be designed using sheet piling to construct a rectangular box. Native material is then excavated and replaced with granular iron with a layer of peat gravel placed on either side of the granular iron. The iron is placed to intercept the saturated thickness of the plume in the treatment zone. The primary factors affecting the capital costs for this system are plume dimensions, upgradient VOC concentrations, and groundwater velocity. Iron filings have been shown to be effective in treating chlorinated solvents. The reaction chemistry involves the simultaneous oxidative corrosion of the reactive iron metal by both water and the chlorinated compounds. Bench-scale treatability tests would be required to determine the degradation rates of VOCs. Using initial VOC concentrations and the degradation rates, the residence time that the groundwater must be in contact with the iron to meet treatment objectives can be determined. The thickness of the reactive zone can be determined knowing the groundwater velocity and the degradation rates from the bench-scale testing. Residence times can vary from 5-50 hours for chlorinated solvents such as TCE, vinyl chloride, and cis-1,2-dichloroethene. Air sparging may be substituted for iron filings to treat groundwater in this system. Advantages of this system over conventional pump and treat systems are that the system is a passive system with low operation and maintenance costs.

Periodic groundwater monitoring would be used to assess the progress of the treatment.

5.4.2.2 Protectiveness

An evaluation of the criterion of Protectiveness must address several issues. The short- and long-term protectiveness to both human health and the environment must be considered. The following discussion will show how this alternative meets these criteria.

Short-term Protectiveness

Several items are included in an assessment of the short-term protectiveness of Alternative MC-3. The first issue is protection of the community during the remedial action. This alternative, like all the other migration control alternatives is protective of the community. All remedial activities associated with this alternative will be conducted onsite. The remediation will be designed and

implemented such that any air emissions generated by the air sparging system will be below all EPA and NYSDEC air quality standards.

There will be little or no threat from releases during the excavation for the trenches. The excavation for the downgradient trench is near the SEDA boundary, where the concentrations of hazardous constituents in the groundwater are very low, and where there were little or no hazardous constituents detected in the soils.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during excavation are direct contact with the affected soil and inhalation of vapors or particulates. As described above, the concentrations of the potentially hazardous constituents in the area of the excavation are very low, which indicates a low potential for worker exposure. There are greater concentrations of these constituents in the areas where the trench near the source area would be installed, but adequate personal protection will be provided.

Protection from exposure can be minimized through site access controls and the use of proper protective equipment for site workers, such as respirators, dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. There will be few environmental impacts. As described above, there is little potential for release of hazardous constituents during the construction of the air sparging system. There are no sensitive environments which will be disturbed by the construction activities.

The last item to be considered is the time until treatment is accomplished. Results from the transport model, MT3D, were used to determine cleanup times for the migration control alternatives, which essentially consist of natural attenuation and passive interceptor trenches. The model simulates the transport of the plume of VOCs under the natural attenuation scenario using both conservative and less conservative input parameters. Because the Migration Control alternatives in the Ash Landfill FS include passive trench systems, the results obtained from the natural attenuation scenario can be used to derive time frames to achieve cleanup levels for these

alternatives as well. The MT3D model accounts for several mechanisms that affect the transport of the plume including biodegradation, dispersion, and adsorption. The individual trench scenarios were not simulated using MT3D because the results from the natural attenuation model runs provide adequate information to derive reasonable time estimates for the passive trench remedial alternatives.

Several scenarios were modeled, however, Scenario 3-B simulates the conditions at the site with the constant source of VOCs removed to reflect the removal action performed in the Spring of 1995. Scenario 3-B uses a degradation value of 0.0005/day, which is considered plausible for the site and depicts a less conservative result. Profile concentration plots at 5 simulation monitoring points along the longitudinal axis of the plume were used to present the results and are shown in Figure 5-4. Analysis of the results for Scenario 3-B indicates that at Points 1 and 2 concentrations are reduced to below 5 ug/L after approximately 12 to 15 years. Point 1 is located in the former source area and upgradient of the first trench and Point 2 is located near the second and more downgradient trench. Therefore, the concentration of the VOCs on-site are predicted to be reduced to below the criteria value (5 ug/L) in approximately 12 to 15 years, which would occur before the groundwater reaches the first trench.

The MT3D modeling results also provide information so that time frames to achieve clean-up levels for off-site locations can be derived. At Point 3, which is located approximately 25 feet west of the SEDA boundary and immediately downgradient of the second proposed trench, the concentrations are reduced to below 5 ug/L after approximately 11 to 15 years. These estimates consider the trenches to be nearly 100% effective in capturing upgradient portions of the plume. Also, the model results indicate that the plume will be completely degraded before it reaches the farm house under Scenario 3-B.

Long-term Protectiveness

The assessment of the long-term protectiveness of Alternative MC-3 can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the controls used for the waste residuals.

The treatment system will be run until the concentrations of TCE and 1,2-DCE in the groundwater are both below 5 μg/L, the NYSDEC criteria for Class GA groundwaters. There will be little or no treatment residuals. Any soils removed for the trench installation will come from areas in which previous soil sampling has indicated little or no soil contamination. Cuttings

Technical Feasibility

The technical feasibility of Alternative MC-3 is average due to the uncertainties associated with an innovative in-situ technology. The basis of this technology is the volatility of the chlorinated organics that are dissolved in the groundwater. As these materials migrate into the interceptor gate, air is bubbled into the collector pipe located at the bottom of the man-hole that causes the dissolved volatile solvents to undergo a phase transfer from the liquid phase to the gaseous phase. The solvent laden air is the collected at the top of the man-hole through another collector pipe that is under negative pressure due to the application of a vacuum. Air sparging systems are easy to implement, but the low hydraulic conductivity soils at the site will limit the flow of water into the gate and therefore treatment time is expected to be long. Hydraulically, there is the potential to cause the groundwater to mound in the area of the gate due to the increase in pressure from the sparging system. This may cause the groundwater plume to spread around the gate area.

Another aspect of technical feasibility is the ease with which additional work may be conducted. This technology will not interfere with other source control remedial activities, since all work will be conducted in a different portion of the site.

Administrative Feasibility

The administrative feasibility of this alternative is good. All work will be conducted on site, and there will be few emissions since sparging air will be collected and treated, if necessary. Construction permits necessary for the activities are readily attainable.

Coordination with the various regulatory agencies is also important. The Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

Availability of Services and Materials

There is good availability of the materials and services necessary to accomplish this alternative. All of the equipment necessary for this technology is standard. The excavation and trench installation equipment is readily available from a number of contractors.

alternatives as well. The MT3D model accounts for several mechanisms that affect the transport of the plume including biodegradation, dispersion, and adsorption. The individual trench scenarios were not simulated using MT3D because the results from the natural attenuation model runs provide adequate information to derive reasonable time estimates for the passive trench remedial alternatives.

Several scenarios were modeled, however, Scenario 3-B simulates the conditions at the site with the constant source of VOCs removed to reflect the removal action performed in the Spring of 1995. Scenario 3-B uses a degradation value of 0.0005/day, which is considered plausible for the site and depicts a less conservative result. Profile concentration plots at 5 simulation monitoring points along the longitudinal axis of the plume were used to present the results and are shown in Figure 5-4. Analysis of the results for Scenario 3-B indicates that at Points 1 and 2 concentrations are reduced to below 5 ug/L after approximately 12 to 15 years. Point 1 is located in the former source area and upgradient of the first trench and Point 2 is located near the second and more downgradient trench. Therefore, the concentration of the VOCs on-site are predicted to be reduced to below the criteria value (5 ug/L) in approximately 12 to 15 years, which would occur before the groundwater reaches the first trench.

The MT3D modeling results also provide information so that time frames to achieve clean-up levels for off-site locations can be derived. At Point 3, which is located approximately 25 feet west of the SEDA boundary and immediately downgradient of the second proposed trench, the concentrations are reduced to below 5 ug/L after approximately 11 to 15 years. These estimates consider the trenches to be nearly 100% effective in capturing upgradient portions of the plume. Also, the model results indicate that the plume will be completely degraded before it reaches the farm house under Scenario 3-B.

Long-term Protectiveness

The assessment of the long-term protectiveness of Alternative MC-3 can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the controls used for the waste residuals.

The treatment system will be run until the concentrations of TCE and 1,2-DCE in the groundwater are both below 5 μg/L, the NYSDEC criteria for Class GA groundwaters. There will be little or no treatment residuals. Any soils removed for the trench installation will come from areas in which previous soil sampling has indicated little or no soil contamination. Cuttings

from the trench installation can be combined with the soils removed from the debris piles, and contained or treated as necessary. Another potential residual is spent activated carbon, if carbon is used to treat the air stream. This carbon would be sent offsite for regeneration or disposal.

5.4.2.3 Reductions

Alternative MC-3 would be effective in reducing the mobility, and volume of the hazardous constituents present at the site, and somewhat effective in reducing the toxicity. The air sparging iron filings will reduce the volume of contaminated groundwater through in-situ treatment. The toxicity of the constituents present in the groundwater will be diminished through aerobic biodegradation and volatilization or through chemical reduction from in the aquifer. If the off gas is treated, the toxicity of the organic constituents will be further reduced.

5.4.2.4 Permanence

The permanence of the alternative must also be assessed. Once the groundwater at the site meets the treatment criteria, the remedial action would be considered permanent. There will be minimal treatment residues, and these residues can be treated and/or disposed of offsite.

5.4.2.5 Compliance with ARARs

Alternative MC-3 will comply with all ARARs. A list of the ARARs for this site is in Appendix C.

5.4.2.6 Implementability

A discussion of implementability can be divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

5.4.2.7 Cost

Capital Costs

Capital costs for the MC-3 alternative (air sparging trenches) are estimated to be $667,800. Capital cost for the MC-3a alternative (funnel-and-gate system) are estimated to be $422,000.

O & M Costs

If carbon is used to treat the off-gas, there are also substantial carbon replacement and regeneration costs. Annual O&M costs for the MC-3 alternative are estimated to be $291,000. Annual O&M costs for the MC-3a alternative are estimated to be $98,000.

Present Worth Costs

The present worth costs for Alternative MC-3 are estimated to be $2.5 million. The present worth cost for this system were estimated with a 10% interest rate and assumes a 10 year treatment time. The present worth costs for Alternative MC-3a are estimated to be $1,023,622.

5.4.3 Analysis of Alternative MC-5: Interceptor Trenches/Tank Storage/ Filtration/Hardness Removal/Air Stripping/Liquid-Phase Carbon/Drainage Ditch Surface Water Discharge

5.4.3.1 Definition of Alternative MC-5

Alternative MC-5 is the first of two "pump-and-treat" alternatives. This alternative, along with Alternative MC-6, consists of the installation of two interceptor trenches, from which the collected groundwater is pumped to a treatment unit. The only difference between this alternative and Alternatives MC-6 is the type of treatment unit.

As shown in Figure 5-6, one interceptor trench would be located as close as possible to the fence which runs along the western boundary of SEDA. This trench will prevent offsite migration of the plume. The other trench will be located in the middle of the plume, and will be constructed in a "V" shape, with a collection sump in the bottom of the "V." The location of the second trench will depend on the results of the trench test, and on the results of the non-time critical removal action that was performed on the soils near the "Bend in the road". This design uses the natural contours of the site to help drain the groundwater. Each trench will be approximately 1000 feet long by 3 feet wide by 8 feet deep. The trenches will extend from the ground surface to the competent shale bedrock. The trenches will be excavated with a bucket loader and the

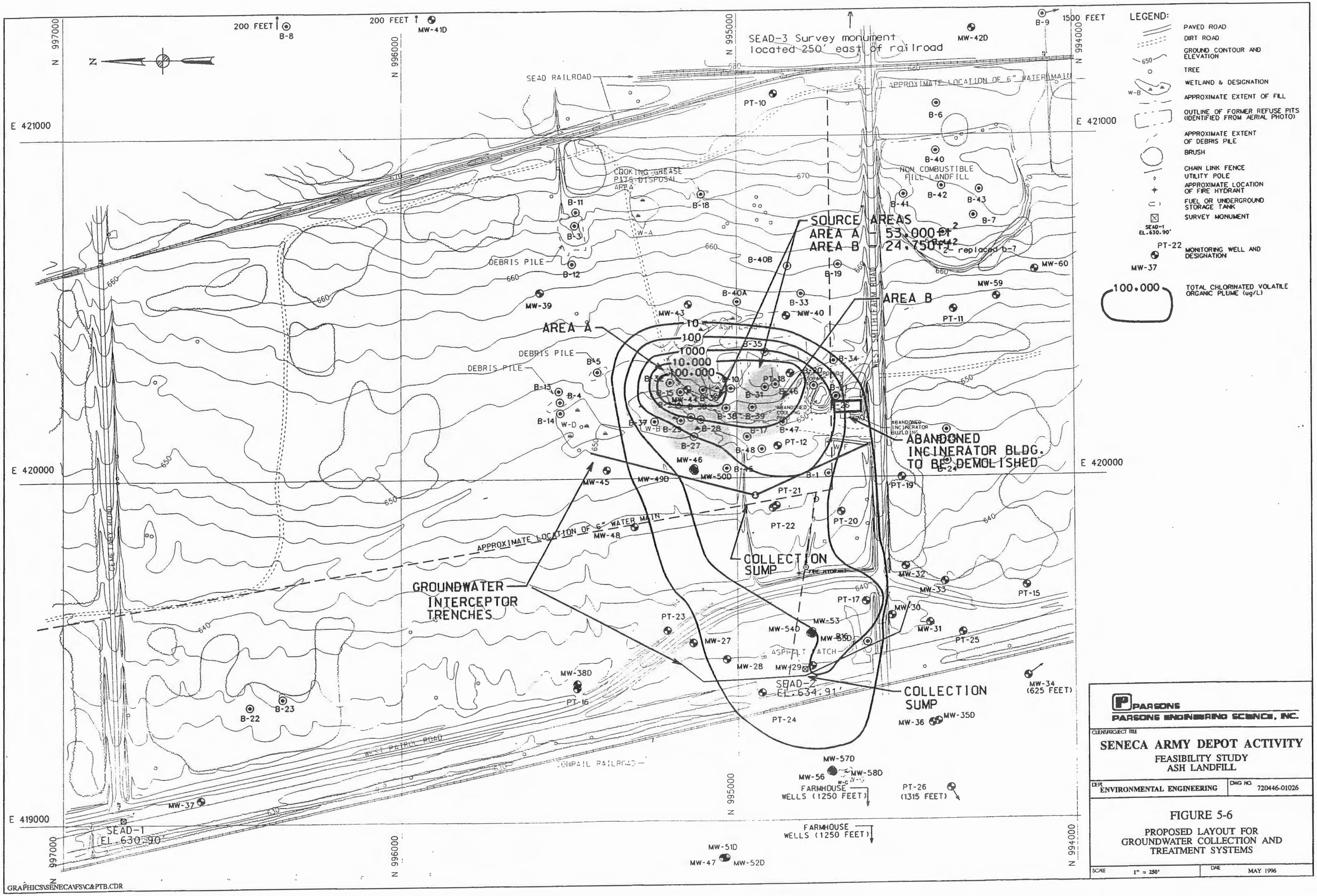
outside walls will be lined with a geotextile filter. Perforated PVC pipe will be placed in the bottom of the trench to facilitate drainage to the collection sumps. The trench will then be filled in with gravel to a depth of 2 to 3 feet below grade. Geotextile will be placed over the gravel, and the trench will be backfilled to grade with the dirt previously removed. Figure 5-7 is a cross-section of the interceptor trench.

The water will be pumped from the trenches to the treatment system. As shown in Figure 5-6, the proposed location of the treatment system is at the old incinerator. If the incinerator building can be restored, it would be advantageous to put the treatment system in the building to minimize the effects of weather. If the incinerator building cannot be salvaged, it would be best to dismantle the building and use the preexisting pad for the treatment system.

The treatment process is shown in Figure 5-8. The first step in the treatment train is an equalization/settling tank. An equalization tank is used to minimize the flow fluctuations going to the treatment unit which are due to seasonal variations in precipitation. It is estimated that a 10,000 gallon tank will be appropriate. The tank will also provide settling capacity. It is anticipated that iron and other metals will begin to precipitate once the groundwater is exposed to oxygen. An overflow weir in the tank will allow the precipitated metals to be removed from the process train. The next step in the treatment process is an inline filter for suspended solids removal. The filter will be followed with a hardness removal unit. An industrial water softener will remove calcium and other minerals from the groundwater. This is an important step because the minerals in groundwater tend to foul the various treatment units.

The next step in the process is the treatment unit. It is at this point that alternatives MC-5 and MC-6 diverge. This alternative relies on an air stripper for removing organics from groundwater. An air stripper uses a countercurrent air stream to extract volatile organics from water. The stripper usually consists of a tower which is filled with trays, plates, or packing material. This devices increase the surface area of contact between the water and the air. The size of the tower is based on the nature of the contaminants and the discharge requirements. The treated water is then discharged. Modelling conducted using the EPA Screen model (Appendix A) indicates that air treatment will not be necessary to meet NYSDEC air standards.

The treated water may be passed through a liquid phase carbon unit and discharged to the drainage ditches adjacent to the patrol roads, eventually being discharged to Kendaia Creek. The carbon unit is not necessary to meet the treatment objectives, but may be used for polishing and protection during process upsets.



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ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING

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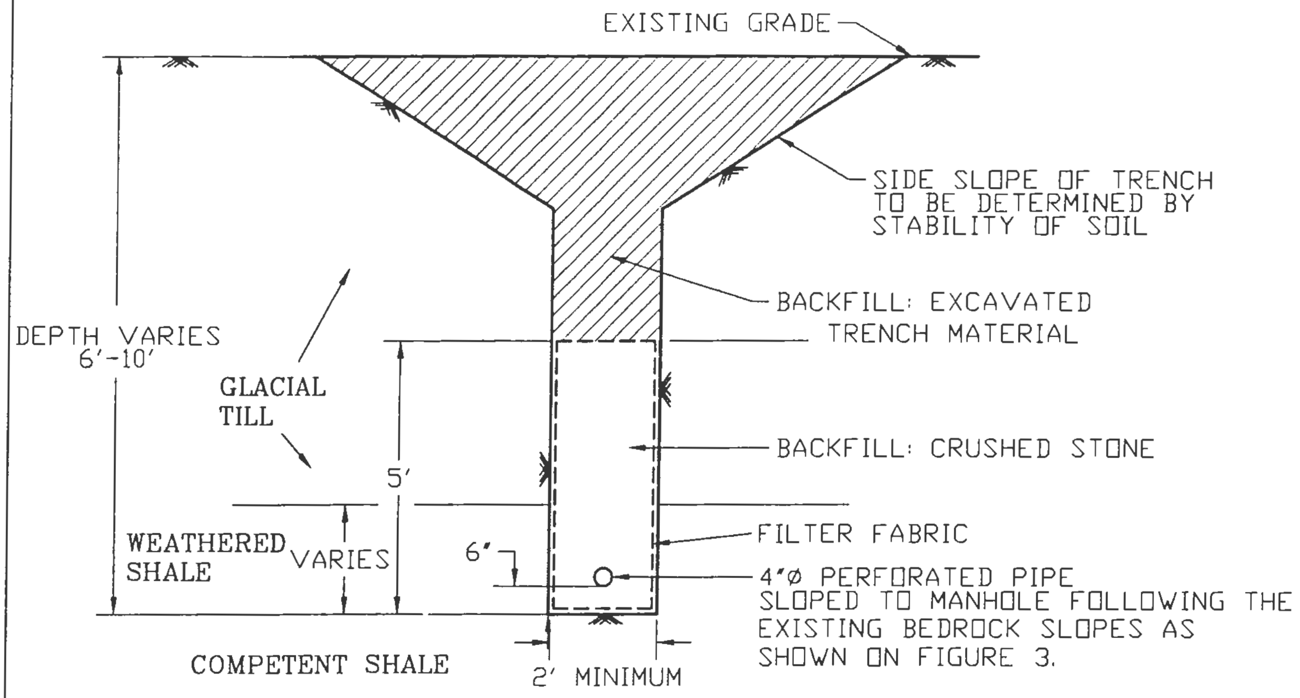
FIGURE 5-6

PROPOSED LAYOUT FOR GROUNDWATER COLLECTION AND TREATMENT SYSTEMS

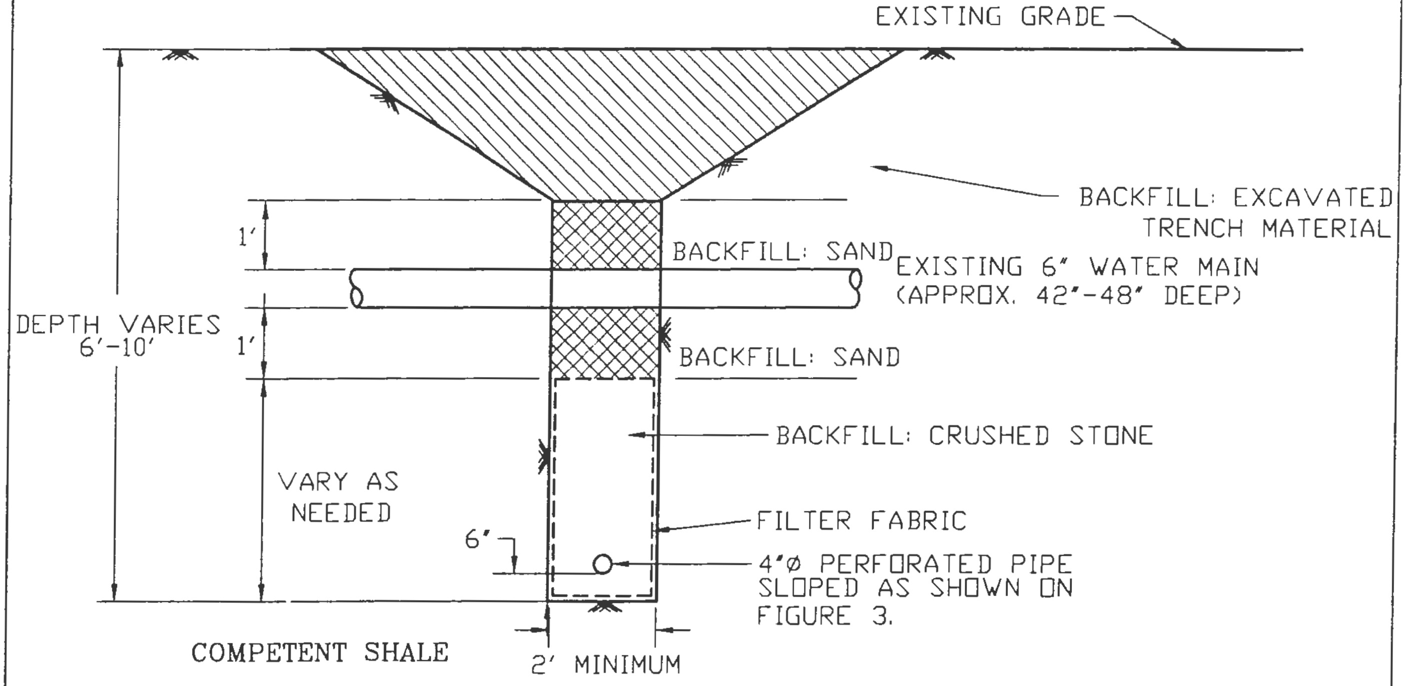
SCALE 1" = 250'

DATE MAY 1996

GRAPHICS\SENECA\FS\C&PTB.CDR



TYPICAL SECTION



DETAIL OF WATER MAIN INTERSECTION

NOTES:

1. EXCAVATION FOR THE INTERCEPTOR TRENCH IS TO BE MADE TO THE TOP OF COMPETENT BEDROCK. (SEE APPENDIX FOR BORING LOGS)
2. MINIMUM TRENCH WIDTH IS 2 FEET.

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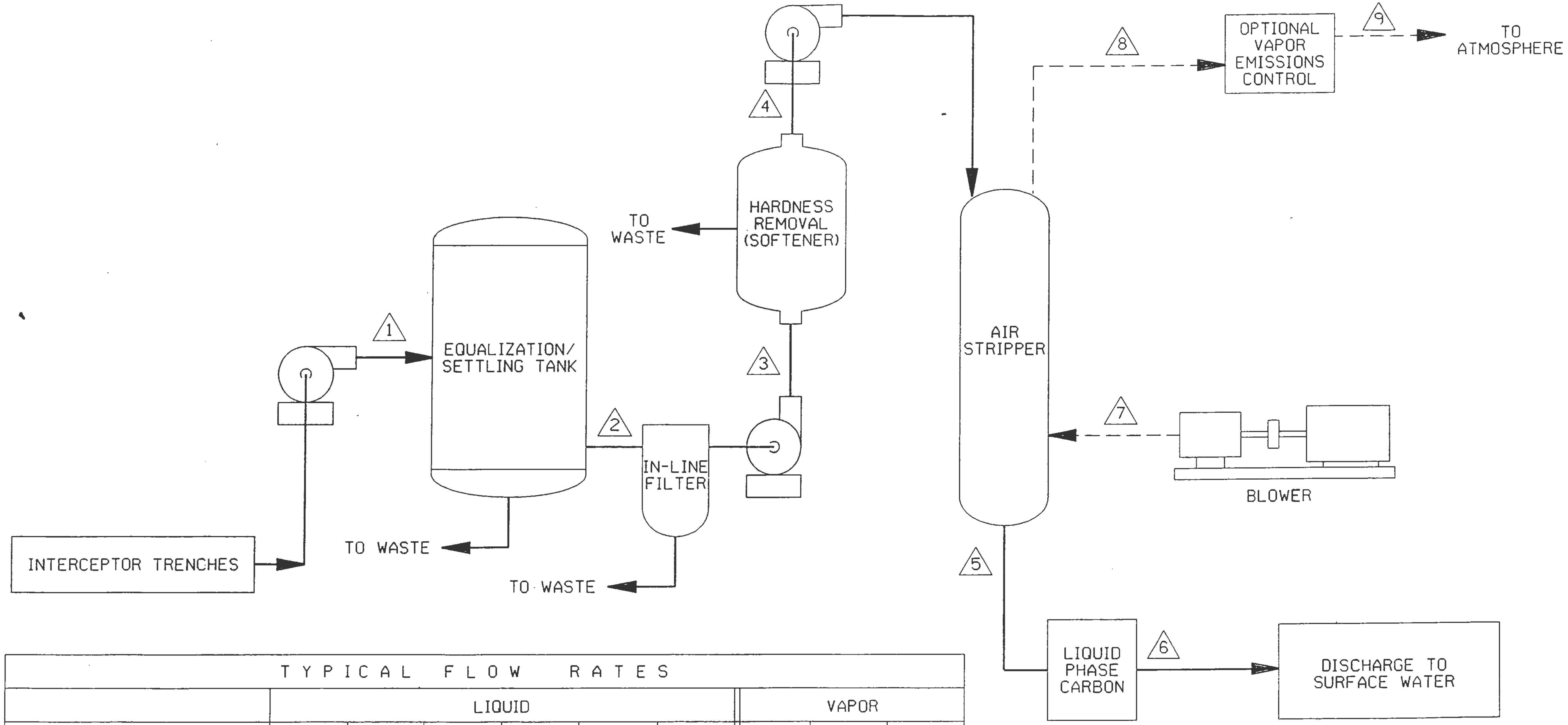
FIGURE 5-7 CROSS SECTIONS
GROUNDWATER COLLECTION AND
TREATMENT SYSTEM

SCALE NONE
DATE SEPTEMBER 1995
REV 1

ACAD\SENECA\ELIZA\FIG3



TYPICAL FLOW RATES

	LIQUID						VAPOR		
STREAM NO.	1	2	3	4	5	6	7	8	9
FLOW RATE (gpm)	20-30	25	25	25	25	25			
TCE (ug/L)	100	100	100	100	<5	<3			
1,2 DCE (ug/L)	100	100	100	100	<5	<3			
HARDNESS (mg/L)	320	320	320	0	0	0			
TSS (mg/L)	180	180	10	5	5	5			
FLOW RATE (m3/S)							0.12	0.12	0.12
TCE (ppmV)							0	0.26	0.03
1,2 DCE (ppm V)							0	0.43	0.04

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FIGURE 5-8
ALTERNATIVE MC-5
PROCESS FLOW SCHEMATIC

SCALE 1" = 250'
DATE MAY 1996

GRAPHICS\SENECA\FS\C&PTB.CDR

5.4.3.2 Protectiveness

An evaluation of the criterion of protectiveness addresses several issues. The short- and long-term protectiveness to both human health and the environment has been considered. The following discussion will illustrate how this alternative meets these criteria.

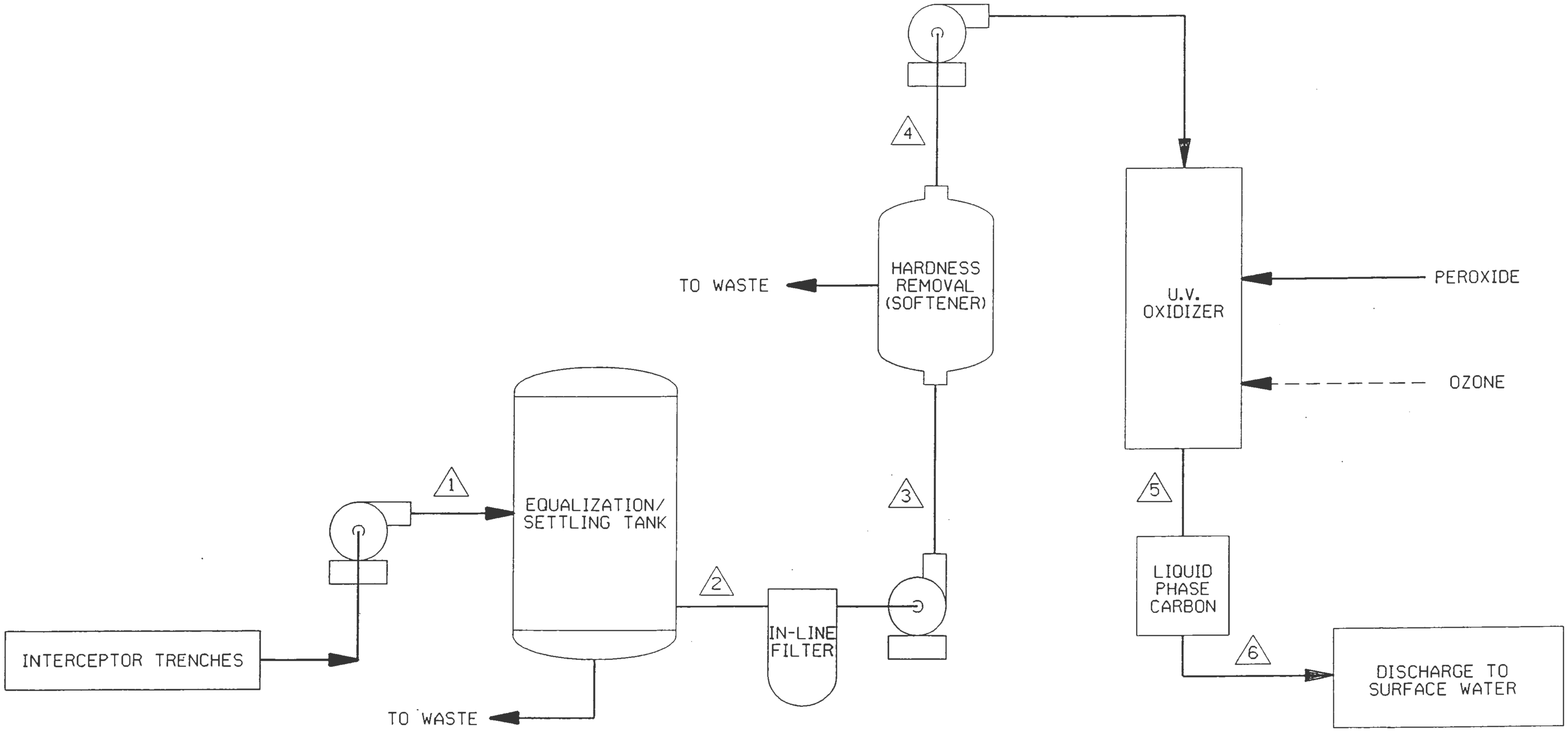
Short-term Protectiveness

The first issue in short-term protectiveness is protection of the community during the remedial action. All remedial activities associated with this alternative will be conducted on-site. There will be little or no threat from releases during the excavation because the non-time critical removal action, which eliminated the source of VOCs in soils at the "Bend in the Road", was completed. Because, the excavations of the interceptor trenches will be in areas where the concentrations of hazardous constituents in the groundwater are low, the emissions from the air stripper will meet all NYSDEC and EPA air standards. Therefore, this alternative is protective of the community.

The short-term protectiveness to site workers has also been considered. The major routes of exposure during excavation, are direct contact with the affected soil and inhalation of vapors or particulates. Because the non-time critical removal action has been completed, the concentrations of the potentially hazardous constituents in the area of the excavations will be minimal to non-existent, and this would mean that there would be a minimal potential for worker exposure. However, it is likely that some level of personal protective equipment will be necessary to minimize worker exposure, as a precaution.

Protection from exposure can be minimized through site access controls and the use of proper protective equipment for site workers, such as respirators, dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. There will be few environmental impacts. As described above, there is little potential for release of hazardous constituents during the excavations. There are no sensitive environments which will be disturbed by the construction activities.



TYPICAL FLOW RATES						
STREAM NO.	1	2	3	4	5	6
FLOW RATE (gpm)	20-30	25	25	25	25	25
TCE (ug/L)	100	100	100	100	<5	<5
1,2 DCE (ug/L)	100	100	100	100	<5	<5
HARDNESS (mg/L)	320	320	320	0	0	0
TSS (mg/L)	180	180	10	5	5	5

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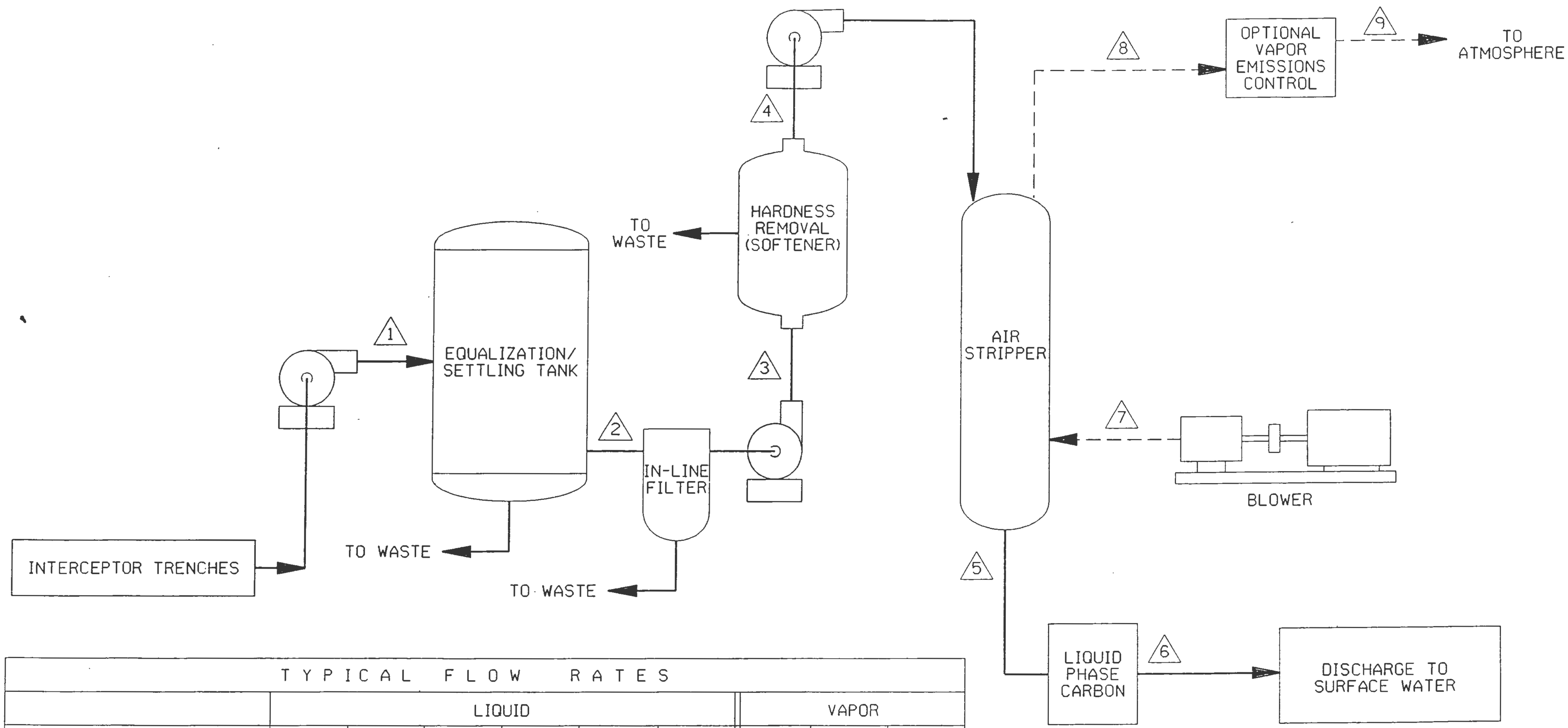
FIGURE 5-9
ALTERNATIVE MC-6
PROCESS FLOW SCHEMATIC

SCALE 1" = 250'
DATE MAY 1996

GRAPHICS\SENECA\FS\C&PTB.CDR



TYPICAL FLOW RATES									
	LIQUID						VAPOR		
STREAM NO.	1	2	3	4	5	6	7	8	9
FLOW RATE (gpm)	20-30	25	25	25	25	25			
TCE (ug/L)	100	100	100	100	<5	<3			
1,2 DCE (ug/L)	100	100	100	100	<5	<3			
HARDNESS (mg/L)	320	320	320	0	0	0			
TSS (mg/L)	180	180	10	5	5	5			
FLOW RATE (m3/S)							0.12	0.12	0.12
TCE (ppmV)							0	0.26	0.03
1,2 DCE (ppm V)							0	0.43	0.04

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DWG NO 720446-01026

FIGURE 5-8
ALTERNATIVE MC-5
PROCESS FLOW SCHEMATIC

SCALE 1" = 250'
DATE MAY 1996

GRAPHICS\SENECA\FS\C&PTB.CDR

5.4.3.2 Protectiveness

An evaluation of the criterion of protectiveness addresses several issues. The short- and long-term protectiveness to both human health and the environment has been considered. The following discussion will illustrate how this alternative meets these criteria.

Short-term Protectiveness

The first issue in short-term protectiveness is protection of the community during the remedial action. All remedial activities associated with this alternative will be conducted on-site. There will be little or no threat from releases during the excavation because the non-time critical removal action, which eliminated the source of VOCs in soils at the "Bend in the Road", was completed. Because, the excavations of the interceptor trenches will be in areas where the concentrations of hazardous constituents in the groundwater are low, the emissions from the air stripper will meet all NYSDEC and EPA air standards. Therefore, this alternative is protective of the community.

The short-term protectiveness to site workers has also been considered. The major routes of exposure during excavation, are direct contact with the affected soil and inhalation of vapors or particulates. Because the non-time critical removal action has been completed, the concentrations of the potentially hazardous constituents in the area of the excavations will be minimal to non-existent, and this would mean that there would be a minimal potential for worker exposure. However, it is likely that some level of personal protective equipment will be necessary to minimize worker exposure, as a precaution.

Protection from exposure can be minimized through site access controls and the use of proper protective equipment for site workers, such as respirators, dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. There will be few environmental impacts. As described above, there is little potential for release of hazardous constituents during the excavations. There are no sensitive environments which will be disturbed by the construction activities.

The last item to be considered is the time until treatment is accomplished. Results from the transport model, MT3D, were used to determine cleanup times for the migration control alternatives, which essentially consist of natural attenuation and passive interceptor trenches. The model simulates the transport of the plume of VOCs under the natural attenuation scenario using both conservative and less conservative input parameters. Because the Migration Control alternatives in the Ash Landfill FS include passive trench systems, the results obtained from the natural attenuation scenario can be used to derive time frames to achieve cleanup levels for these alternatives as well. The MT3D model accounts for several mechanisms that affect the transport of the plume including biodegradation, dispersion, and adsorption. The individual trench scenarios were not simulated using MT3D because the results from the natural attenuation model runs provide adequate information to derive reasonable time estimates for the passive trench remedial alternatives.

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The MT3D modeling results also provide information so that time frames to achieve clean-up levels for off-site locations can be derived. At Point 3, which is located approximately 25 feet west of the SEDA boundary and immediately downgradient of the second proposed trench, the concentrations are reduced to below 5 ug/L after approximately 11 to 15 years. These estimates consider the trenches to be nearly 100% effective in capturing upgradient portions of the plume. Also, the model results indicate that the plume will be completely degraded before it reaches the farm house under Scenario 3-B.

Long-term Protectiveness

The assessment of the long-term protectiveness of Alternative MC-5 can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the controls used for the waste residuals.

The treatment system will be run until the concentrations of TCE and 1,2-DCE in the groundwater are both below 5 μg/L, the NYSDEC criteria for Class GA groundwaters. This value for TCE, 5 ug/l, is equivalent to the MCL. There will be little or no treatment residuals. Any soils removed for the trenches will be from areas in which previous soil sampling has indicated little or no soil contamination. This soil can be used as fill. Other soils could be treated on-site or sent off-site to an appropriate treatment, storage, and disposal facility. The only potential treatment residual is spent activated carbon; if carbon is used to polish the liquid stream. This carbon would be sent offsite for regeneration or disposal.

5.4.3.3 Reductions

Alternative MC-5 would effectively reduce the mobility, toxicity, and volume of the hazardous constituents present at the site. The interceptor trenches will effectively eliminate the mobility of the plume, and ensure that no additional offsite migration occurs. The volume of contaminated groundwater will decrease over time as the organics are attenuated.

5.4.3.4 Permanence

The permanence of the alternative has also been assessed. Once the groundwater at the site meets the treatment criteria, the remedial action would be considered permanent. There will be minimal treatment residues, and these residues can be treated and/or disposed of offsite.

5.4.3.5 Compliance with ARARs

Alternative MC-5 will comply with all ARARs. A list of the ARARs for this site is in Appendix C.

5.4.3.6 Implementability

The discussion of implementability is divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring

considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

Technical Feasibility

The technical feasibility of Alternative MC-5 is high. Interceptor trenches will collect more water than individual recovery wells, which are limited by a small radius of influence. Air stripping is a proven technology for volatile organic compounds, and both TCE and 1,2-DCE are volatile. Activated carbon could be used as a final effluent polishing step and has been proven to be effective in capturing TCE and 1,2-DCE.

Another aspect of technical feasibility is the ease with which additional work may be conducted. This technology will not interfere with the source control remedial activities, since all work can be conducted in a different portion of the site.

Administrative Feasibility

The administrative feasibility of this alternative is very good. All work will be conducted on site, and air emissions will be controlled using appropriate control equipment. Air stripper vendors have extensive experience in complying with air emission regulations. Construction permits necessary for the activities are readily attainable.

Coordination with the various regulatory agencies is also important. As discussed previously, the Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

Availability of Services and Materials

There is good availability of the materials and services necessary to accomplish this alternative. All of the equipment necessary for this technology is standard. The excavation and treatment equipment is readily available from a number of contractors.

5.4.3.7 Cost

Capital Costs

Capital costs for Alternative MC-5 are estimated to be $543,000. Engineering and oversight costs are also included.

O & M Costs

Annual O&M costs, including quarterly groundwater monitoring, are estimated to be $130,000. Assuming a 10% interest rate, the 30 year present worth O&M costs are $1.2 million. This includes energy, equipment maintenance, and replacement of spent carbon and filter beds.

Present Worth Costs

The total present worth costs for Alternative MC-5 are the sum of the O&M present worth cost and the capital costs and have been estimated to be $1.8 million

5.4.4 Analysis of Alternative MC-6: Interceptor Trenches/Tank Storage/Filtration/ Hardness Removal/UV Oxidation/Liquid-Phase Carbon/Drainage Ditch Surface Water Discharge

5.4.4.1 Definition of Alternative MC-6

Alternative MC-6 is the second of the "pump-and-treat" alternatives. This alternative, like Alternative MC-5 above consists of the installation of two interceptor trenches, from which the collected groundwater is pumped to a treatment unit. The only difference between this alternative and alternative MC-5 is the type of treatment unit. The collection system for this alternative is the same as for Alternative MC-5, above. The interceptor trenches and treatment unit will be located as shown in Figure 5-4. The treatment process is shown in Figure 5-9. The first few steps in the treatment train are also the same as for Alternative MC-5. These steps are an equalization/settling tank, a filter, and a softener.

The next step in the process is the treatment unit. Alternative MC-6 uses a UV Oxidation unit as the treatment device. As described in Section 3.0, UV Oxidation is a treatment technique which combines ultraviolet (UV) light with an oxidizing agent (peroxide and/or ozone) to destroy organic constituents in the liquid phase. It is especially effective for chlorinated organics, such as TCE and 1,2-DCE, the constituents of concern at the Ash Landfill. The water is mixed with peroxide, and then enters the UV reaction chamber. Ozone is added to the reaction chamber, and OH radicals are formed. The formation of the hydroxyl (OH) radicals is catalyzed by the UV light. Hydroxyl radicals are strong oxidizing agents and react rapidly with the chlorinated

organics, generating carbon dioxide, chloride and water. If ozone is used in the treatment process, any ozone not reacted is decomposed in an offgas treatment unit prior to discharge.

There are several vendors of UV Oxidation equipment with extensive experience in groundwater treatment, each of which utilize the formation of hydroxyl radicals as the basis of the treatment process but have different system configurations. The three most prominent UV oxidation vendors include: Ultrox Inc., Peroxidation Systems, Inc., and the Solarchem Rayox™.

The primary advantage to the UV Oxidation systems over the air stripper is the complete destruction of the organics in the liquid phase. Unlike, an air stripper or liquid phase carbon there is no phase transfer of pollutants. Instead, the organics are converted to carbon dioxide, chloride and water and there are no air emissions from the unit. Although UV oxidation has several advantages as a treatment process including: no air emissions, destruction of the chlorinated organic constituents in one step and demonstrated effectiveness there are some disadvantages. One aspect of this technology this is unattractive are the problems associated with fouling of the UV lamps. Since the UV reactor produces strong oxidizing conditions, other constituents dissolved in the water are oxidized. In the case of iron, a brown oxide precipitates over the reactor and coats the UV lamps decreasing the amount of the UV light that can enter the reaction chamber. The result is a decrease in treatment effectiveness. Vendors, such as Solarchem, have incorporated automatic wipers that remove the unwanted oxide buildup and eliminate the problem. Other disadvantages include frequent lamp breakage, large electrical power consumption and "short circuiting" of the process water in the UV reaction chamber due to inefficient contact time.

As described above, the treated water will be passed through an activated carbon polishing step and discharged to the drainage ditches along the patrol roads.

5.4.4.2 Protectiveness

The following discussion will address the short- and long-term protectiveness to both human health and the environment of this alternative.

Short-term Protectiveness

The first issue in short-term protectiveness is protection of the community during the remedial action. This alternative is protective of the community. Like the previous alternatives, all remedial activities associated with this alternative will be conducted onsite. There will be little or no threat from releases during the excavation. The excavations of the interceptor trenches will

be in areas where the concentrations of hazardous constituents in the groundwater are low, and where there were little or no hazardous constituents detected in the soils. Measures will be taken during the trenching to minimize volatile emissions.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during excavation, as described above, are direct contact with the affected soil and inhalation of vapors or particulates. There is a potential for worker exposure while installing the trenches and personal protective equipment will be necessary to minimize worker exposure.

Protection from exposure can be minimized through site access controls and the use of proper protective equipment for site workers, such as respirators, dust masks and Tyvek protective clothing. Air monitoring well be used to determine if there is a threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. There will be few environmental impacts since the only effluent is the treated groundwater. There will be no potentially hazardous air emissions. There is a potential for ozone emissions if ozone addition is required for additional treatment, but the ozone decomposition unit will eliminate impacts due to ozone.

The last item to be considered is the time until treatment is accomplished. Results from the transport model, MT3D, were used to determine cleanup times for the migration control alternatives, which essentially consist of natural attenuation and passive interceptor trenches. The model simulates the transport of the plume of VOCs under the natural attenuation scenario using both conservative and less conservative input parameters. Because the Migration Control alternatives in the Ash Landfill FS include passive trench systems, the results obtained from the natural attenuation scenario can be used to derive time frames to achieve cleanup levels for these alternatives as well. The MT3D model accounts for several mechanisms that affect the transport of the plume including biodegradation, dispersion, and adsorption. The individual trench scenarios were not simulated using MT3D because the results from the natural attenuation model runs provide adequate information to derive reasonable time estimates for the passive trench remedial alternatives.

Several scenarios were modeled, however, Scenario 3-B simulates the conditions at the site with the constant source of VOCs removed to reflect the removal action performed in the Spring of

1995. Scenario 3-B uses a degradation value of 0.0005/day, which is considered plausible for the site and depicts a less conservative result. Profile concentration plots at 5 simulation monitoring points along the longitudinal axis of the plume were used to present the results and are shown in Figure 5-4. Analysis of the results for Scenario 3-B indicates that at Points 1 and 2 concentrations are reduced to below 5 ug/L after approximately 12 to 15 years. Point 1 is located in the former source area and upgradient of the first trench and Point 2 is located near the second and more downgradient trench. Therefore, the concentration of the VOCs on-site are predicted to be reduced to below the criteria value (5 ug/L) in approximately 12 to 15 years, which would occur before the groundwater reaches the first trench.

The MT3D modeling results also provide information so that time frames to achieve clean-up levels for off-site locations can be derived. At Point 3, which is located approximately 25 feet west of the SEDA boundary and immediately downgradient of the second proposed trench, the concentrations are reduced to below 5 ug/L after approximately 11 to 15 years. These estimates consider the trenches to be nearly 100% effective in capturing upgradient portions of the plume. Also, the model results indicate that the plume will be completely degraded before it reaches the farm house under Scenario 3-B.

Long-term Protectiveness

The assessment of the long-term protectiveness of Alternative MC-6 is divided into an assessment of the magnitude of the residual risk and an evaluation of the adequacy and reliability of the controls used for the waste residuals.

The magnitude of the residual risk is easy to quantify. The treatment system will operate until the concentrations of TCE and 1,2-DCE in the groundwater are both below 5 μg/L, the NYSDEC criteria for Class GA groundwaters. For TCE, the Class GA groundwater standard, 5 ug/l, is equivalent to the MCL. There will be little or no treatment residuals other than some sludge collected from the UV oxidation system, equalization tank and the filtration process. The primary residual is the soils removed during trench installation. Once dewatered, this soil is expected to be used as fill. The groundwater recovery trends will be in areas downgradient of the source soils and it is unlikely that soil contamination will be significant since the organic carbon content of saturated soils is likely to be low, i.e. <0.1%. As a result, there is little partioning of dissolved chlorinated solvents to the soil and groundwater is considered the media of concern.

5.4.4.3 Reductions

Alternative MC-6 would effectively reduce the mobility, toxicity, and volume of the hazardous constituents present at the site. The interceptor trenches will effectively eliminate the mobility of the plume, and ensure that no offsite migration occurs. The toxicity of the organic constituents will be greatly reduced because the organics will be destroyed in the UV oxidation unit. The volume of contaminated groundwater will decrease over time as the organics are removed.

5.4.4.4 Permanence

The permanence of the alternative must also be assessed. Groundwater treatment systems are temporary systems and are only required until the remedial goals are obtained. If the source of groundwater impacts is removed the time to achieve the goals will be decreased. Once the groundwater at the site meets the treatment criteria, the remedial action would be considered complete and the system would be dismantled. Providing proper O&M is performed, the treatment system will be permanent for the duration of the remedial action.

5.4.4.5 Compliance with ARARs

Alternative MC-6 will comply with all ARARs. A list of the ARARs for this site is in Appendix C.

5.4.4.6 Implementability

The discussion of implementability is divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

Technical Feasibility

The technical feasibility of Alternative MC-6 is very high. As describe above, interceptor trenches will effectively collect groundwater. UV oxidation has been used at a number of sites to treat chlorinated organic compounds, and often achieves effluent concentrations well below the 5 μg/L required for this project.

Another aspect of technical feasibility is the ease with which additional work may be conducted. This technology will not interfere with the source control remedial activities, since all work will be conducted in a different portion of the site. This alternative will not preclude any future remedial activities at the site.

Administrative Feasibility

The administrative feasibility of this alternative is very good. All work will be conducted on site, and there will be almost no emissions. Construction permits necessary for the activities are readily attainable.

Coordination with the various regulatory agencies is also important. As discussed previously, the Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

Availability of Services and Materials

There is good availability of the materials and services necessary to accomplish this alternative. All of the equipment necessary for this technology is standard. All three of the vendors contacted during the FS, Ultrox, Peroxidation Systems, and Solarchem, have appropriate sized unit available. The excavation and treatment equipment is readily available from a number of contractors.

5.4.4.7 Cost

Capital Costs

Capital costs include the same unit operations as alternative MC-5, except the air stripper is replaced by a UV oxidation unit. Capital costs are estimated to be $556,000.

O & M Costs

Annual O&M costs are also similar to those of alternative MC-5. Annual O&M costs are estimated to be approximately $139,000. The present worth O&M costs, assuming a 10% interest rate and a 30 year operation has been estimated at $1.3 million.

Present Worth Costs

The total present worth costs for Alternative MC-6 are estimated to be $1.9 million. This is the sum of the capital costs and the 30 year O&M costs.

5.5 COMPARATIVE ANALYSIS OF MIGRATION CONTROL (MC) ALTERNATIVES

5.5.1 Introduction

The purpose of this section is to compare each of the Migration Control alternatives to each other with respect to the specific evaluation criteria. The following discussion will rate each of the alternatives with regards to the evaluation criteria and identify the relative advantages and disadvantages of each. This comparison will provide the information necessary to decide the most appropriate alternative for this site.

The discussion is divided into two groups. The first group, the threshold criteria, include the overall protection of human health and the environment and includes compliance with ARARs. The next group considers the remainder of the evaluation criteria: long term effectiveness and permanence, reduction of toxicity, mobility, and volume through treatment, short-term effectiveness, implementability, and cost. Table 5-2 provides a summary of the analysis of each alternative in terms of the criteria.

5.5.2 Threshold Criteria

The first two criteria are overall protection of human health and the environment and compliance with ARARs. These are called threshold criteria because each alternative must meet these in order to be carried through the process. Alternatives which do not meet these criteria were eliminated prior to the detailed analysis of alternatives.

5.5.3 Other Considerations

5.5.3.1 Long Term Effectiveness and Permanence

The migration control alternatives will provide long-term effectiveness and permanence. All including the natural attenuation alternative (MC-2) are capable of reducing VOCs in the

Table 5-2
Individual Evaluation of Migration Control Alternatives

Criteria	Alternative MC-2 Natural Attenuation/ Instutional Controls	Alternative MC-3 Air-Sparging of Plume	Alternative MC-5 Interceptor trench/ Air Stripping/	Alternative MC-6 Interceptor trench/ UV Oxidation/
OVERALL PROTECTIVENESS				
Reduce and improve non-carcinogenic and cancer risk levels for current and intended future receptors	Risk for current and future land use is 1 x 10E-4 HI = 0.24 VOCs in groundwater not posing a threat to human health because ingestion of on-site groundwater not exposure pathway.	Risk eliminated by removing TCE and 1,2-DCE in groundwater to 5 ug/L (NYSDEC GA criteria).	Treatment system will run until concentrations of TCE and 1,2-DCE in groundwater is below 5 ug/L.	Treatment system will operate until concetrations of TCE and 1,2-DCE in the groundwater are below 5 ug/L (NYSDEC GA criteria).
Prevent off-site migration of constituents above levels protective of public health and the environment	Some uncertainty since off-site land cannot be controlled, however contingency plan to protect off-site receptors is part of alternative.		Trenches will prevent off-site migration.	Trenches will prevent off-site migration.
COMPLIANCE WITH ARARs	Will comply with all ARARs over time.	Will comply with all ARARs.	Will comply with all ARARs.	Will comply with all ARARs.
LONG-TERM EFFECTIVENESS AND PERMANANCE				
Magnitude of Residual Risk	Sources have been removed.	Little or no treatment residuals.	Little or no treatment residuals.	Little or no treatment residuals other than some sludge collected from OV system.

Table 5-2
Individual Evaluation of Migration Control Alternatives

Criteria	Alternative MC-2 Natural Attenuation/ Instutional Controls	Alternative MC-3 Air-Sparging of Plume	Alternative MC-5 Interceptor trench/ Air Stripping/	Alternative MC-6 Interceptor trench/ UV Oxidation/
Permanence	Permanent solution overtime.	Once groundwater meets criteria, remedial action considered permanent.	Once groundwater meets criteria, remedial action considered permanent.	Once groundwater meets criteria, remedial action considered permanent.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT				
Reduction of Toxicity, Mobility, or Volume	Reduction in VOC concentrations to below criteria over time.	Air sparging will reduce volume Reduction in toxicity by aerobic degradation and volatilization.	Trench will eliminate mobility of plume. Volume of contaminants in groundwater will decrease.	Trenches will eliminate mobility of plume. Toxicity greatly reduced by UV oxidation unit.
SHORT-TERM EFFECTIVENESS				
Community Protection	Risk to community not increased by remedy implementation	Air emissions from air sparging will be below all EPA and NYSDEC air quality standards.	Little or no threat to community; emissions from air stripper will meet NYSDEC and EPA air standards.	Little or no threat to the community
Worker Protection	No significant risk to workers	Protection required against dermal contact and inhalation of contaminated dust during excavation	Protection required against dermal contact and inhalation of contaminated dust during excavation	Protection required against dermal contact and inhalation of contaminated dust during excavation

Table 5-2
Individual Evaluation of Migration Control Alternatives

Criteria	Alternative MC-2 Natural Attenuation/ Instutional Controls	Alternative MC-3 Air-Sparging of Plume	Alternative MC-5 Interceptor trench/ Air Stripping/	Alternative MC-6 Interceptor trench/ UV Oxidation/
Environmental Impacts	Continued impacts from existing conditions	Little potential for release of hazardous constituents during construction of air sparging system.	Few environmental impacts.	Potential ozone emissions; however, ozone decomposition unit will be utilized.
Time Until Action is Complete	Not applicable	Air sparging complete in 25 to 30 years.	May be necessary to run air stripper for 4 to 8 yrs. Construction and start-up will take 2 to 4 months.	Treatment time is 4 to 8 years. Construction and startup will take 2 to 4 months.
IMPELEMETABILITY				
Technical Feasibility	No construction or operation. Institutional controls.	Some uncertainties with innovative in-situ technology, although successful applications have been implemented.	Air stripping and activated carbon are proven technologies.	UV oxidation has been used successfully at a number of sites to treat chlorinated organic compounds.
Ease of Doing More Action if Needed	Will not interfere with other source control activities.	Will not interfere with other source control activities.	Will not interfere with other source control activities.	Will not interfere with other source control activities.
Ability to Obtain Approvals and Coordinates with Other Agencies	No approval necessary	Construction permits readiliy obtainable.	Construction permits readility obtainable. Air stripping vendors have extensive experience in complying with air emission regulations	Construction permits readility obtainable.
Availablility of Services and Materials	No services or capacities required.	All equipment is standard.	Equipment is standard.	Vendors available for UV Oxidation unit.

Table 5-2
Individual Evaluation of Migration Control Alternatives

Criteria	Alternative MC-2 Natural Attenuation/ Instutional Controls	Alternative MC-3 Air-Sparging of Plume	Alternative MC-5 Interceptor trench/ Air Stripping/	Alternative MC-6 Interceptor trench/ UV Oxidation/
COST				
Capital Cost	$60,000	$668,000	$543,000	$556,000
Annual O&M Cost	$792,000	$1,790,000	$1,222,000	$1,308,000
Present Worth Cost	$852,000	$2,500,000	$1,800,000	$1,900,000

groundwater to levels below the NYSDEC Class GA standards. Once the groundwater concentration reaches the desired concentration, the remedial action will be considered complete and permanent. The key differences between the alternatives are in the time necessary to achieve the criteria, and in the quantity and nature of the treatment residuals.

Alternative MC-3 (air sparging) and MC-5 and MC-6 (the "pump-and-treat" alternatives) will likely required 15 years, since these are dependent on the removal of groundwater (Appendix A). However, the time necessary to achieve the remedial action objectives for groundwater is likely to be significantly reduced because the source of VOCs in soil was removed during the non-time critical removal action.

The differences between the treatment residuals are easier to quantify. The natural biodegradation alternative, MC-2, has no treatment residuals, since there is no treatment. The primary residuals from alternative MC-3, air sparging is spent carbon if vapor emission control is required. The treatment residuals from the other alternatives are similar. All have many of the same unit operations. All will generate sludge from the filter backwash if a softener is utilized there will be softener regeneration water, and spent carbon from the carbon polishing unit. The air stripper and UV oxidation units will also generate residuals, from the oxidation of iron and possibly from calcium buildup is a softener is not used. Air strippers can also generate a biological slime that must be periodically removed.

5.5.3.2 Reductions

The migration control alternatives have also been evaluated for reductions in toxicity, mobility, and volume. All of the alternatives, including the natural degradation alternative MC-2 reduce the mobility of pollutants. Alternative MC-3 uses air sparging trenches to prevent offsite migration of the contaminant plume, while alternatives MC-5 and MC-6, use an interceptor trenches to collect groundwater for treatment.

There are substantial differences in the toxicity reductions achieved by the alternatives. The natural degradation alternative, MC-2, achieves a reduction in toxicity through natural attenuation of the constituents in the plume. All the other alternatives use active measures to reduce the toxicity.

Alternative MC-6, UV oxidation achieve the greatest reduction in toxicity. The potentially hazardous organics are effectively destroyed in the treatment process, where they are converted

completely to nonhazardous substances. Untreated organics are captured during the carbon polishing step, and are destroyed during the carbon regeneration process. In alternative MC-5, air stripping, the toxicity of the constituents in groundwater is reduced by transferring of the constituents from the groundwater to the air. Alternative MC-3, air sparging reduces the toxicity through a combination of the above methods. Alternative MC-2 relies on natural attenuation to destroy the organics due to interactions between biological material and the pollutants.

All of the alternatives are effective in reducing the volume of the hazardous constituents at the site. The volume of groundwater which exceeds the NYSDEC criteria will be reduced over time as organics are removed from the groundwater. This reduction is expected to be expedited now that the source of VOCs in groundwater has been is eliminated.

5.5.3.3 Short-term Effectiveness

All of the migration control alternatives rate fairly well for short-term effectiveness. The interceptor or air sparging trenches would be installed in areas of little or no soil contamination, so there would be minimal risk of exposure during installation of the system. Also, during any excavation operation, all air emissions will meet federal and state criteria, which will minimize the risk to the community. In addition, all operations will be conducted within the fenceline, so site access will be restricted. Alternative MC-6 (UV oxidation) rated the best because this option has little or no air emissions and is effective in eliminating pollutants.

5.5.3.4 Implementability

Alternative MC-2 natural degradation rates the best with regard to technical implementability, but rates low for administrative implementability due to probable regulatory disagreement because groundwater concentrations currently exceed the NY State GA groundwater standard. However, they are expected to meet these standards overtime. Alternatives MC-5, air stripping, and MC-6, UV oxidation rate high on a technical basis because both of alternatives rely on standard equipment that is readily available from a number of vendors, and because the standard technologies are generally well documented and proven and have a high degree of acceptance.

Alternative MC-3, air sparging, rates moderately due to the uncertainties of implementing an in-situ technology. Alternative MC-3, also scores lower because it is not a proven technology, and the available vendors and equipment are somewhat limited.

5.5.4 Cost

The natural attenuation alternative (MC-2) is the most cost effective, since the only costs are those associated with continued quarterly groundwater monitoring and possibly institutional controls. MC-3a, funnel-and-gate, had the next overall lowest total costs after MC-2. Alternative MC-3, air sparging has the highest total costs because of the high O&M costs. MC-4 liquid phase carbon was the next highest in cost after MC-3, also because of O&M costs.

The estimated present worth costs of the two "pump-and-treat" alternatives are similar, ranging from $1.8 million for alternative MC-5 (air stripping) to $1.9 million for alternative MC-6 (UV Oxidation). The similarity of these costs is not unexpected, because these alternatives use many of the same unit operations for collection, pre-treatment, and discharge. The only differences are in the actual treatment step.

5.6 CONCLUSIONS FOR MIGRATION CONTROL

As described above, all of the alternatives described in the detailed analysis would be effective for the Migration Control remedial action at the Ash Landfill for the future intended use of the site.

Alternatives MC-2, 3, 5, and 6 were determined to meet the site specific remedial objectives for groundwater. All four alternatives rank equally for long-term protectiveness of human health and the environment. That is, the alternatives are effective in reducing the concentration of constituents of concern to below the NYSDEC GA or Federal standards and protecting off-site receptors. All alternatives rank equally in reducing toxicity, mobility, and volume of hazardous constituents. The difference between the alternatives is in the time-to-compliance.

Alternative MC-2 ranks highest in terms of technical implementability. Alternatives MC-5 and MC-6 rank lower in terms of technical implementability, and Alternative MC-3 ranks lower because it is an innovative technology.

Alternative MC-2 ranks highest for costs because the only costs associated with this alternative are for groundwater monitoring and possible institutional controls.

Alternative MC-3a ranked high for total costs but low on short-term protectiveness and long term monitoring.

APPENDIX A

Calculations

Calculation of Average VOC Concentrations in Groundwater

CLIENT	USACE	JOB NO. 720447	SHEET 1 OF 2
SUBJECT	SEDA Ash Landfill FS	BY DMK	DATE 12/22/93
	Estimate Groundwater Concentrations	CKD.	REVISION

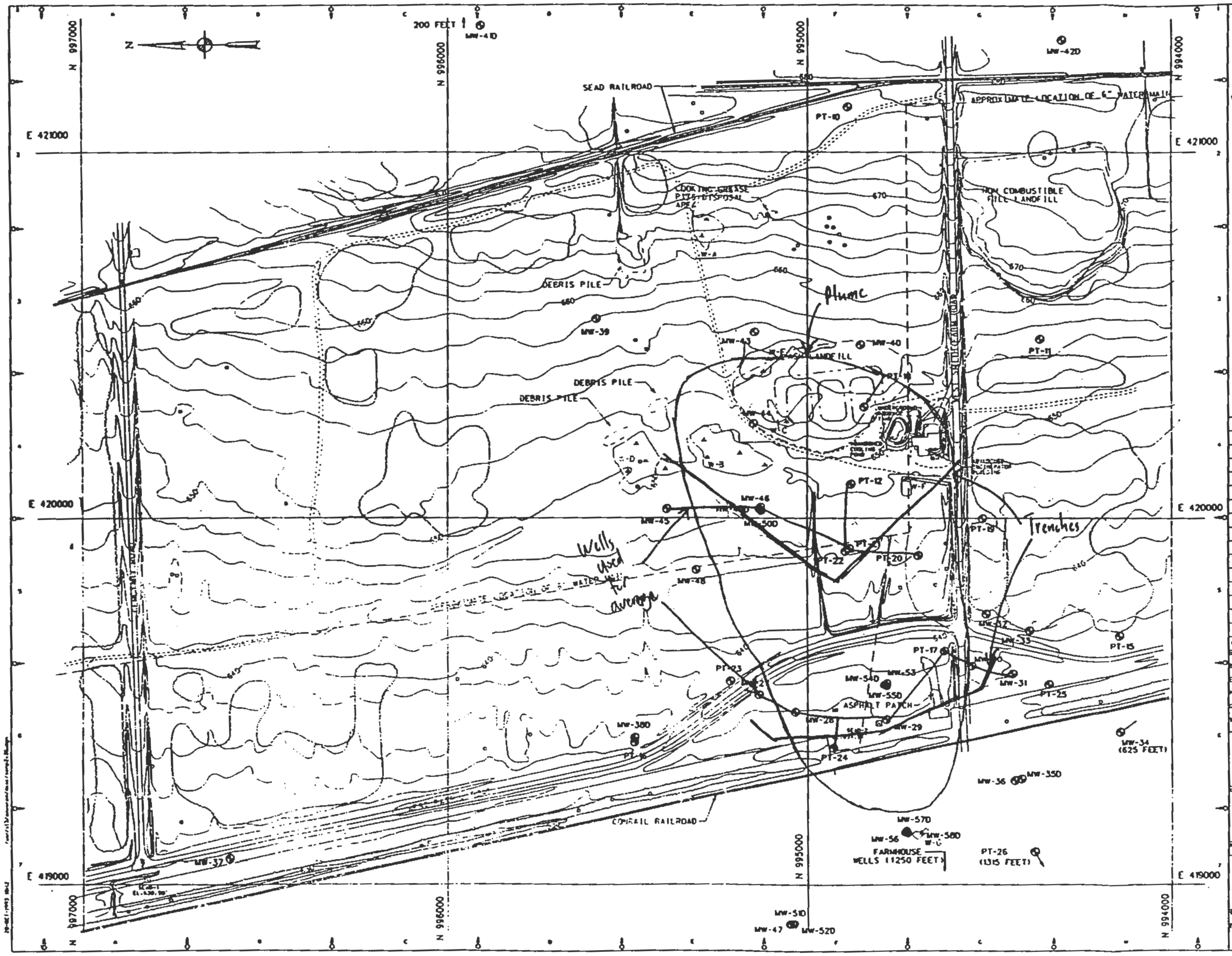
Use average concentrations of wells:

MW-45
MW-46
PT-20
PT-21
PT-22
PT-12
MW-27
MW-28
MW-29
MW-30
MW-31
PT-17
PT-24

	Phase I			Phase II		
Well	TCE	1,2 DCE	Vinyl chloride	TCE	1,2 DCE	Vinyl Chloride
PT-12	180	195	4 †	970	1400	88
PT-17	260	53	0	190	43	0
PT20	25	24	0	37	53	0
PT-21	2	16	0	3	14	0
PT-22	80	100	0	98	150	0
MW27	0	0	0	0	0	0
MW-28	33	61	0	35	53	0
MW-29	1	71	0	2	97	0
MW-30	0	0	0	1	0	0
MW-31	0	0	0	0	0	0
MW-45	–	–	–	0	0	0
MW-46	–	–	–	47	120	0
PT-24	4	100	0	4	62	0
Avg:	53	56	0.4	107	153	7

		use	
TCE :	82	100 µg/L	These likely have a high bias due to PT-12.
DCE :	108	120 µg/L	
Vinyl Chloride:	4	4 µg/L	

4/c



B		PROGRESS PHASE II REPORT					
A		ISSUED WITH PRELIMINARY SITE CHARACTERIZATION REPORT					
REV	DATE	DESCRIPTION					

DRAWN BY C.A.KAELIN	CHECKED BY [illegible]
DESIGN ENG. C.A.KAELIN	REV. ENG. [illegible]
CHIEF ENG. ENGR. W.E.BAKER	HEAD OF ENGR. J.P.CHAPLICK
PROJECT MANAGER M.R.DUCHESNEAU	
MGR. OF PROJECTS J.P.CHAPLICK	
VP OFFICE W.D.PATTERSON	

ES
ENGINEERING-SCIENCE, INC.

SENECA ARMY DEPOT
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING — 720447-03000

FIGURE 2-8
LOCATION OF
MONITORING WELLS

SCALE 1" = 250'

720447-03000-2-7 — B

Calculation of Groundwater Flow Rate into Interceptor Trench

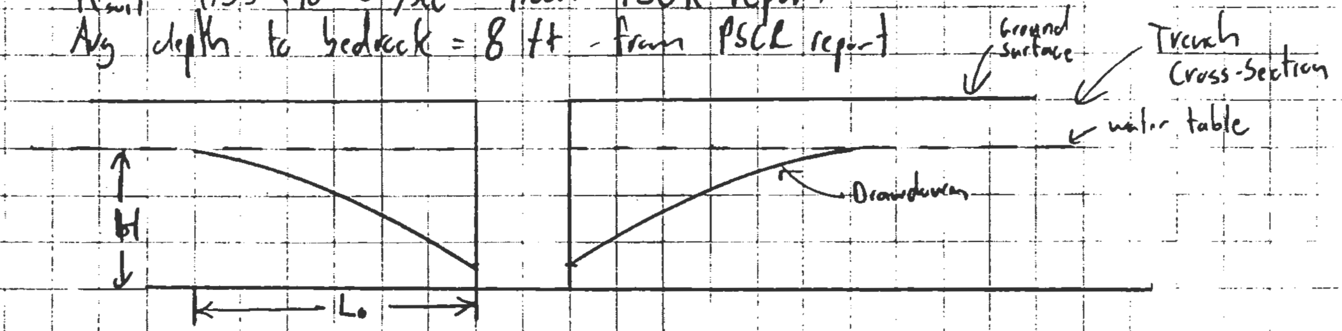
ES ENGINEERING-SCIENCE, INC.

Client USACE
Subject Estimate flow into dewatering trench
Job No. 720489-01000
By DMK
Checked
Sheet 1 of 7
Date 6/15/93
Rev.

Given:
SEAD Ash Landfill, as shown on attached drawing

Length of trench ≅ 800 ft

$K_{soil} = 1.35 \times 10^{-4}$ cm/sec from PSCR report
Avg depth to bedrock = 8 ft - from PSCR report



⇒ Calculate inflow per unit length of trench

Two phases to dewatering:
1) Initial water loss during excavation
2) Steady state flow

Area to dewater ≅ 68,138 ft²

Max water level = 8 ft

Effective porosity ≅ 30% (from de Marsily, 1986)

water to remove = 68,138 × 8 × 0.3 = 163,531 ft3

× 7.48 gal/ft3 = 1.22×10^{6} gallons to dewater

Estimate Aquifer Properties (after Driscoll, 1986)

$T \cong KH = 1.35 \times 10^{-4} \frac{cm}{sec} \times 8 ft \times \frac{30.48 cm}{ft} = 0.033\ cm^2/sec = 3.6 \times 10^{-5}\ ft^2/sec$
for 4 ft $= 0.017\ cm^2/sec = 1.8 \times 10^{-5}\ ft^2/sec$

Client USACE
Job No. 720489-01000
Sheet 2 of 4
Subject Estimate flow into dewatering trench
By DMK
Date 6/13/93
Checked
Rev.

$S \doteq 0.2$ for unconfined aquifers (Driscoll, 1986, p-737)

From Driscoll, equ. 22.7

$$\frac{Q}{x} = \frac{K(H^2-h^2)}{2880 L_o} \quad \text{-for one side of trench}$$

Q = discharge, gpm
x = unit length of trench, ft
K = hydraulic conductivity, gpd/ft^2
H = saturated thickness prior to dewatering, ft
h = depth of water in trench during pumping, ft
L_o = distance to pt of no drawdown, ft

Let $x = 1$ ft for unit flow

$K = 1.35 \times 10^{-4}\ \text{cm}/\cancel{\text{sec}} \times (86{,}400\ \cancel{\text{sec}}/\text{day})(1\ \text{ft}/30.48\ \cancel{\text{cm}}) = 0.383\ \text{ft/day}$

$0.383\ \text{ft/day} \times 7.48\ \text{gal/ft}^3 = 2.86\ \text{gpd/ft}^2$

H = maximum of 8 ft
$h \doteq 1$ ft

$Q = (1\text{ft})(2.86\ \text{gpd}/\cancel{\text{ft}^2})(8^2 - 1^2)\cancel{\text{ft}^2}(1/2880)(1/L_o\ \text{ft})$

$Q = \frac{0.0626}{L_o}$ gpm per ft of trench

If $H = 4$ ft
$Q = 0.0149/L_o$ gpm per ft of trench

Client USACE

Subject Estimate flow into dewatering trench

Job No. 720489-01000

By DMK

Checked

Sheet 3 of 4

Date 6/15/93

Rev.

Estimate L_o

$$R_o = 2L_o = r_s + \sqrt{\frac{Tt}{C_4 S}}$$ (Powers, 1992, eq. 6.13)

r_s = radius of one well
assume r_s = trench thickness = 3 ft

$C_4 = \underline{4790}$ (table 4.2 - Powers)

$T = 3.6 \times 10^{-5}\ \mathrm{ft^2/sec} \times 86{,}400\ \mathrm{sec/day} \times 7.48\ \mathrm{gal/ft^3} = 23.27\ \mathrm{gpd/ft}$

t - time (minutes)
$S = 0.2$

$$R_o = 3\,\mathrm{ft} + \sqrt{\frac{(23.27)\ t\,(\mathrm{min})}{(4790)(0.2)}}$$

$$R_o = 3 + 0.16\sqrt{t}$$

t (days)	R_o (ft)	L_o (ft)	Q (gpm)	Q (gpd)
1	9	4.5	0.0139	20
2	11.6	5.8	0.0108	15.5
5	16.6	8.3	0.0075	10.9
10	22.2	11.1	0.0056	8.1
20	30	15	0.0042	6.0
50	46	23	0.0027	3.9
100	64	32	0.0020	2.8

for 8 ft water table - unit length

4 of 4

Estimation of Flow into Dewatering Trench
SEAD Ash Landfill

Into 1 side of trench

Units

t = time (days)
R0 = radius of influence (feet)
L0 = length of influence = R0/2 (feet)

Q = flow (gpm)
Qd = flow (gpd)
Cum. Flow (gallons)

Calculations for 8–foot water table

t	R0	L0	Q	Qd	Cum. Flow	Cum Flow per 1000ft
0.1	4.9	2.5	0.0254	36.6	3.66	3664
0.2	5.7	2.9	0.0219	31.5	6.82	6819
0.5	7.3	3.6	0.0172	24.7	14.23	14235
1	9.1	4.5	0.0138	19.9	24.17	24172
2	11.6	5.8	0.0108	15.6	39.73	39732
5	16.6	8.3	0.0076	10.9	72.36	72360
10	22.2	11.1	0.0056	8.1	112.97	112966
20	30.2	15.1	0.0042	6.0	172.76	172757
50	45.9	23.0	0.0027	3.9	290.51	290509
100	63.7	31.9	0.0020	2.8	431.99	431987
200	88.9	44.4	0.0014	2.0	634.87	634866
300	108.2	54.1	0.0012	1.7	801.55	801548
400	124.4	62.2	0.0010	1.4	946.44	946437
500	138.8	69.4	0.0009	1.3	1076.36	1076361

Calculations for 4–foot water table

t	R0	L0	Q	Qd	Cum. Flow	Cum Flow per 1000ft
0.1	4.3	2.2	0.0069	9.9	0.99	993
0.2	4.9	2.4	0.0061	8.8	1.88	1875
0.5	6.0	3.0	0.0050	7.2	4.04	4038
1	7.2	3.6	0.0042	6.0	7.03	7029
2	8.9	4.5	0.0033	4.8	11.85	11849
5	12.3	6.2	0.0024	3.5	22.29	22286
10	16.2	8.1	0.0018	2.6	35.53	35531
20	21.7	10.8	0.0014	2.0	55.34	55335
50	32.5	16.3	0.0009	1.3	94.93	94927
100	44.7	22.4	0.0007	1.0	142.88	142882
200	62.0	31.0	0.0005	0.7	212.06	212059
300	75.3	37.6	0.0004	0.6	269.05	269047
400	86.5	43.2	0.0003	0.5	318.67	318666
500	96.3	48.2	0.0003	0.4	363.21	363209

Estimation of Flow into Dewatering Trench
SEAD Ash Landfill

Into both sides
of trench
-upper bound on flow

Units

t = time (days)
Ro = radius of influence (feet)
Lo = length of influence = R0/2 (feet)

Q = flow (gpm)
Qd = flow (gpd)
Cum. Flow (gallons)

Calculations for 8–foot water table

t	Ro	Lo	Q	Qd	Cum. Flow	Cum Flow per 1000ft
0.1	4.9	2.5	0.0509	73.3	7.33	7329
0.2	5.7	2.9	0.0438	63.1	13.64	13638
0.5	7.3	3.6	0.0343	49.4	28.47	28470
1	9.1	4.5	0.0276	39.7	48.34	48344
2	11.6	5.8	0.0216	31.1	79.46	79464
5	16.6	8.3	0.0151	21.8	144.72	144721
10	22.2	11.1	0.0113	16.2	225.93	225932
20	30.2	15.1	0.0083	12.0	345.51	345514
50	45.9	23.0	0.0055	7.9	581.02	581018
100	63.7	31.9	0.0039	5.7	863.97	863975
200	88.9	44.4	0.0028	4.1	1269.73	1269732
300	108.2	54.1	0.0023	3.3	1603.10	1603096
400	124.4	62.2	0.0020	2.9	1892.87	1892875
500	138.8	69.4	0.0018	2.6	2152.72	2152722

Calculations for 4–foot water table

t	Ro	Lo	Q	Qd	Cum. Flow	Cum Flow per 1000ft
0.1	4.3	2.2	0.0138	19.9	1.99	1987
0.2	4.9	2.4	0.0122	17.6	3.75	3750
0.5	6.0	3.0	0.0100	14.4	8.08	8076
1	7.2	3.6	0.0083	12.0	14.06	14058
2	8.9	4.5	0.0067	9.6	23.70	23697
5	12.3	6.2	0.0048	7.0	44.57	44573
10	16.2	8.1	0.0037	5.3	71.06	71062
20	21.7	10.8	0.0028	4.0	110.67	110671
50	32.5	16.3	0.0018	2.6	189.85	189854
100	44.7	22.4	0.0013	1.9	285.76	285764
200	62.0	31.0	0.0010	1.4	424.12	424117
300	75.3	37.6	0.0008	1.1	538.09	538095
400	86.5	43.2	0.0007	1.0	637.33	637331
500	96.3	48.2	0.0006	0.9	726.42	726417

Calculation of Estimated Duration of Groundwater Pump and Treatment System

PARSONS MAIN, INC. **PARSONS**

CLIENT: USACE
JOB NO. 730447
SHEET 1 OF 9
SUBJECT: SEDA Ash Landfill FS
Estimate Treatment Time
BY: DMK
DATE: 7/8/94
CKD.:
REVISION:

I Estimate mass of contaminants at site

A) Estimate mass of contaminants in groundwater

Assumptions
average concentrations apply within contours except 100,000 where assume 125,000
6-foot water table
30% porosity
Plume is 45% TCE, 45% DCE, 10% vinyl chloride

Area of 100,000 ppb contour = 20,000 ft^2
Volume of water = 20,000 (ft^2) × (6ft) × 0.30 = 36,000 ft^3
= 269,280 gal = 1.02×10^6 liters

Area of 10,000 ppb contour = 63,750 − 20,000 = 43,750 ft^2
Volume of water = 43,750 × 6 × 0.3 = 78,750 ft^3 = 2.23×10^6 liters

Area of 1,000 ppb contour = 137,812 − 63,750 ≅ 74,000 ft^2
Volume of water = 74,000 × 6 × 0.3 = 133,200 ft^3 = 3.77×10^6 liters

Area of 100 ppb contour = 371,875 − 137,812 ≅ 234,000 ft^2
Volume of water = 234,000 × 6 × 0.3 = 421,200 ft^3 = 11.92×10^6 liters

Area of 10 ppb contour = 735,000 − 371,875 ≅ 363,000 ft^2
Volume of water = 363,000 × 6 × 0.3 = 653,400 ft^3 = 18.50×10^6 liters

Mass of contaminants in water ≅

$(1.02 \times 10^6 \text{ liters})(125,000\ \mu g/L) + (2.23 \times 10^6)(50,000) + (3.77 \times 10^6)(5000) +$
$(11.92 \times 10^6)(500) + (18.50 \times 10^6)(50)$

$= 2.64 \times 10^{11}\ \mu g$ = 264,735 g

$\boxed{= 583 \text{ pounds}}$

CLIENT: USACE JOB NO: 720447 SHEET: 2 OF: 9

SUBJECT: SEDA Ash Landfill FS BY: DMK DATE: 7/8/94

Estimate Treatment Time CKD.: REVISION:

The proposed removal action covers most of the 100,000 ppb, 10,000 ppb, and half of the 1000 ppb contour

The mass of VOCs outside the removal action =

$$s)(377 \times 10^6) 5000 + (11.92 \times 10^6)(500) + (18.50 \times 10^6)(50) = 1.63 \times 10^{10} \mu g$$
$$= 36 \text{ pounds}$$

B) Estimate mass of contaminants in soil

Look at average concentration within the Bend in the Road area. Little VOCs were detected in the bulk of the plume.

Assume 15,000 yd³
Bulk density = 1.6 g/cm³

$$15{,}000 \text{ yd}^3 \times 1.6 \text{ g/cm}^3 \times 0.76456 \text{ m}^3/\text{yd}^3 \times \frac{100^3 \text{ cm}^3}{\text{m}^3} = 1.83 \times 10^{10} \text{ g soil}$$
$$= 1.83 \times 10^7 \text{ kg/soil}$$

$$\text{mass TCE} = 25{,}000 \ \mu g/kg \times 1.83 \times 10^7 \text{ kg} = 4.57 \times 10^{11} \mu g$$
$$= 457{,}500 \text{ g}$$
$$= 1000 \text{ pounds}$$

Similarly - mass DCE = 210 pounds
mass VC = 18 pounds

Total in soil = 1238 pounds

Subtract mass in water in bend in road area = 583 - 36 = 547 pounds

Total mass = 1238 + 547 = ~~691~~ 1821 pounds

PARSONS MAIN, INC. PARSONS

CLIENT USACE	JOB NO 720447	SHEET 3 OF 9	
SUBJECT SEDA Ash Landfill FS	BY DMK	DATE 7/11/94	
Estimate Treatment Time	CKD.	REVISION	

c) Estimate average concentration in treated water

i) without removal action
2) with removal action

1) Without removal action

Trench 1 (use PT-12 concentrations)
TCE = 970 μg/L
DCE = 1400 μg/L
VC - 88 μg/L

Trench 2 (use MW-27, MW-28, MW-29, MW-30, PT-24)

TCE = 10 μg/L
DCE = 50 μg/L
VC = 0 μg/L

Avg Concentration in treated
TCE = 500 μg/L
DCE = 725 μg/L
VC = 44 μg/L

2) With removal action
TCE = 100 μg/L   from previous calcs.
DCE = 120 μg/L
VC = 4 μg/L

PARSONS MAIN, INC. **PARSONS**

CLIENT USACE
SUBJECT SEDA Ash Landfill FS
Estimate Treatment Time
JOB NO. 720447
BY PMK
CKD.
SHEET 4 OF 9
DATE 7/11/94
REVISION

D) Estimate treatment time

1) Calculate volume of water treated per year
- assume 30 gpm, 300 days

Volume = 30 gal/min × 60 min/hour × 24 hour/day × 300 day/year × 1 year

= 12.96×10^6 gal/year
= 49.06×10^6 L/year

Concentrations treated:
a) without removal action : 500 + 725 + 44 = 1269 µg/L
b) with removal action = 100 + 120 + 4 = 224 µg/L

Mass removed:
a) without removal action : 1269 µg/L × 49.06×10^6 L/year = 62,257 g = 137 pounds
b) with removal action : 224 µg/L × 49.06×10^6 L/year · 11,000 g = 24 pounds

Check % removal of mass

a) without removal action. 137/691 = 20%
b) with removal action : 24/36 = 67%

Check goal assume total final conc. of 10 µg/L

Without removal action.
10 µg/L) × (37.44×10^6 L) = 374.4 g = 0.82 pounds

With removal action 342 g = 0.75 pounds

CLIENT USACE JOB NO 720447 SHEET 5 OF 9
SUBJECT SEDA Ash Landfill FS BY DMK DATE 7/11/94
Estimate Treatment Time CKD. REVISION

Assume percent reduction in mass is constant each year

a) without removal action

year	Mass Start	Mass End	
1	~~694~~ 583	554	
2	554	443	
3	443	354	
4	354	283	
5	283	226	
10	93	74	
20	10	8	
25	3.3	2.6	
30	1.1	0.86	
31	0.86	0.69	✓ Goal is Met

b) With removal action

year	Mass Start	Mass End	
1	36	12	
2	12	4	
3	4	1.3	
4	1.3	0.43	✓ Goal Met

For cost estimate, use:
a) without removal action: 40 years } safety factor
b) with removal action: 8 years }

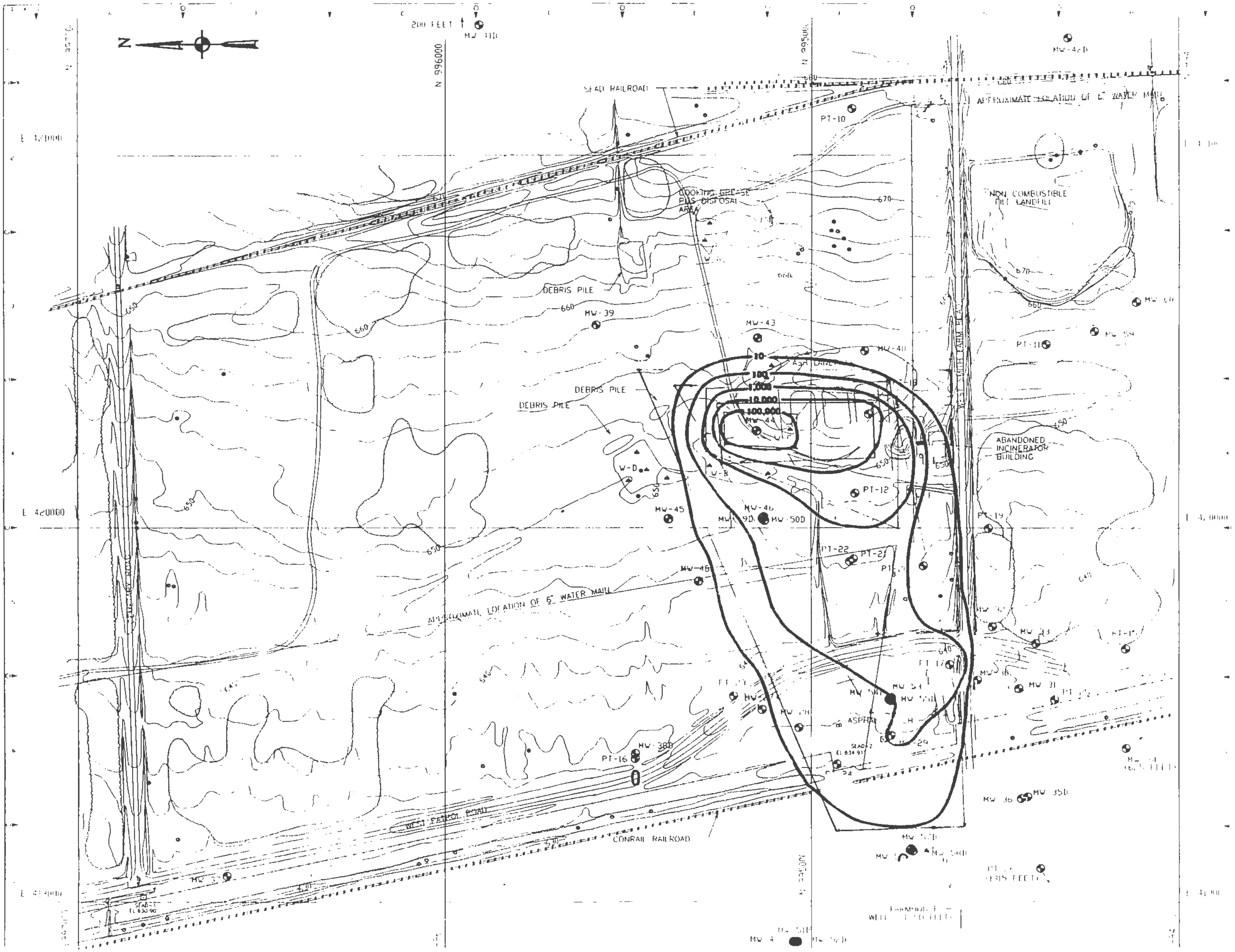
BEND IN THE ROAD AREA
VALIDATED DATA (PHASES I & II)
POTENTIAL CHEMICALS OF CONCERN
SOIL ANALYSIS RESULTS

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	units	COUNT	MAXIMUM		LOGNORMAL MEAN	ARITHMETIC MEAN	STD.DEV	COEF OF VARIATION	NORMAL/ LOGNORMAL
Volatile Organics									
Vinyl Chloride	ug/Kg	63	14,500		429	453.23	1,833.03	4.04	LOGNORMAL
1,2-Dichloroethene (total)	ug/Kg	63	79,000		33,193	5,317.01	12,968.29	2.44	LOGNORMAL
Trichloroethene	ug/Kg	63	540,000		51,003	25,115.37	92,415.66	3.68	LOGNORMAL

0/4

1/9



PAVED ROAD
DIRT ROAD
GROUND CONTOUR AND ELEVATION
TREE
WETLAND & DESIGNATION
APPROXIMATE EXTENT OF
OUTLINE OF FORMER TRACKS IDENTIFIED FROM AERIAL PHOTO
APPROXIMATE EXTENT OF DEBRIS PILE
BRUSH
CHAIN LINK FENCE
UTILITY POLE
APPROXIMATE LOCATION OF FIRE HYDRANT
FILL OF UNDERGROUND STORAGE TANK
SURVEY MONUMENT
MONITORING WELL AND DESIGNATION
—10 000— GROUNDWATER ISOCONCENTRATION

ISSUED WITH PRELIMINARY SITE CHARACTERIZATION REPORT

DESCRIPTION

DRAWN BY G.A. PASTIN
CHECKED BY M.E. BAKER
DESIGNED BY G.A. PASTIN
M.N. DUCHESNEAU
J.P. CHAPLICK
M.E. BAKER
PROJECT MANAGER M.N. DUCHESNEAU
J.P. CHAPLICK
R.D. PATTERSON

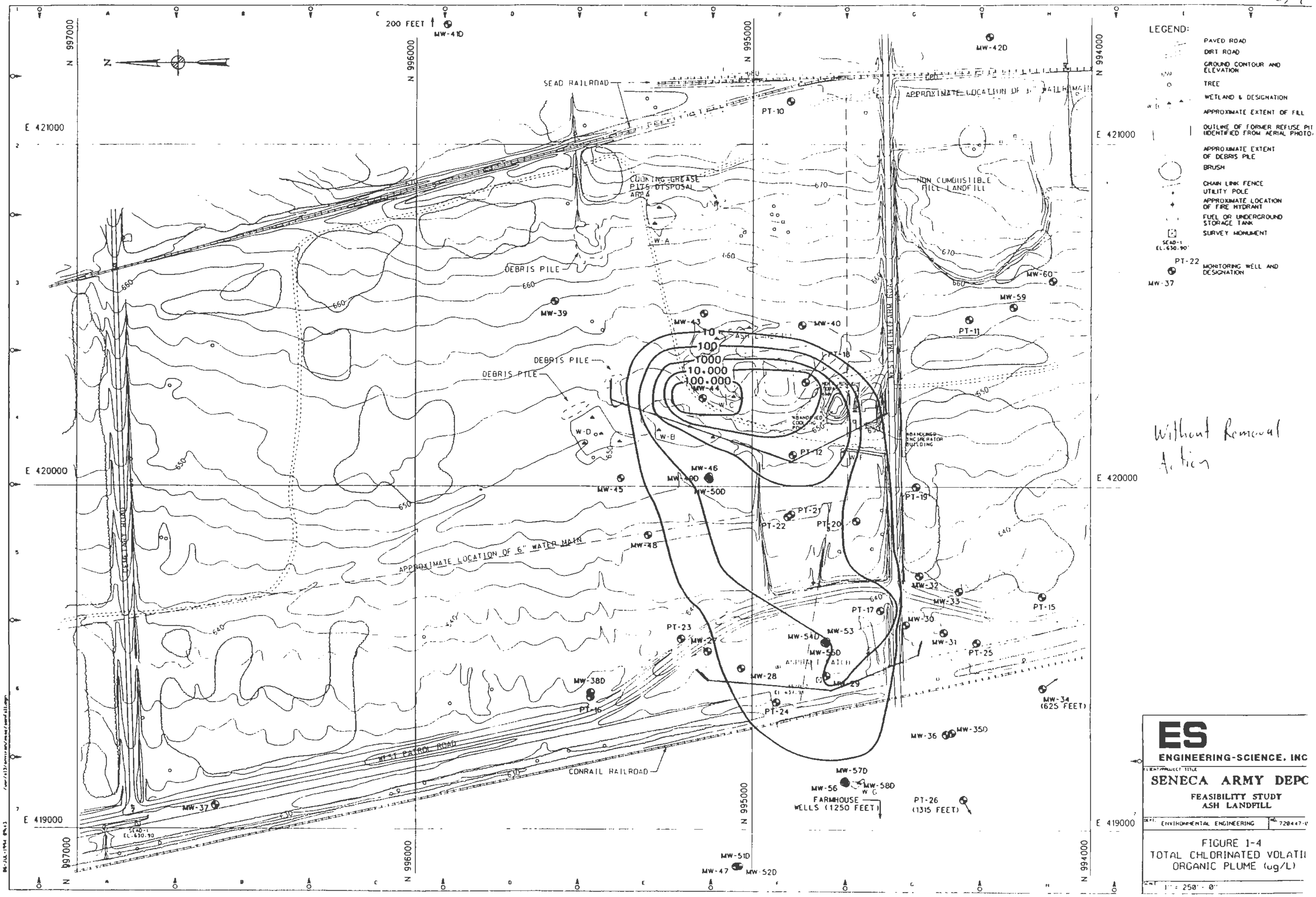
ENGINEERING-SCIENCE, INC

SENECA ARMY DEPOT
REMEDIAL INVESTIGATION
FEASIBILITY STUDY
ASH LANDFILL

ENVIRONMENTAL ENGINEERING

FIGURE 1-1B
TOTAL CHLORINATED VOLATILE
ORGANIC PLUME (ug/L)

3/1



Without Removal Action

ES
ENGINEERING-SCIENCE, INC

CLIENT/PROJECT TITLE
SENECA ARMY DEPC
FEASIBILITY STUDY
ASH LANDFILL

DEPT. ENVIRONMENTAL ENGINEERING
NO. 720447-0

FIGURE 1-4
TOTAL CHLORINATED VOLATII
ORGANIC PLUME (ug/L)

SCALE 1" = 250' - 0"

Calculation of Estimated Air Emmissions from Groundwater Air Stripper Treatment System

CLIENT USACE JOB NO. 720447 SHEET 1 OF 5
SUBJECT SEDA Ash Landfill FS BY DMK DATE 1/4/94
Evaluate Air Emissions from stripper CKD. REVISION

1) Determine 95th % U.C.L. of wells:

PT-12	PT-24	MW-31
PT-17	MW-27	MW-45
PT-20	MW-28	MW-46
PT-21	MW-29	
PT-22	MW-30	

	Phase I			Phase II			
Well	TCE	1,2 DCE	Vinyl Chloride	TCE	1,2 DCE	Vinyl Cl	Trench
PT-12	180	195	4	970	1400	88	1
PT-17	260	53	7	190	43	5	2
PT-20	25	24	5	37	53	5	1
PT-21	2	16	5	3	14	5	1
PT-22	80	100	5	98	150	5	1
PT-24	4	100	5	4	62	5	2
MW-27	2.5	2.5	5	0.25	0.25	0.25	2
MW-28	33	61	5	35	53	5	2
MW-29	1	71	5	2	97	5	2
MW-30	2.5	2.5	5	1	0.25	0.25	2
MW-31	2.5	2.5	5	0.25	0.25	0.25	2
MW-45	—	—	—	45	51[illegible]	5	1
MW-46	—	—	—	47	120	5	1

	TCE		1,2 DCE		Vinyl Cl	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Trench 1:	145	295	208	424	13	26
Trench 2:	38	81	39	37	4	2

Check normality (See attached spreadsheets)

2/5

ESTIMATION OF UNCONTROLLED AIR EMISSIONS FROM AIR STRIPPER

1.) ESTIMATE CONCENTRATION OF TCE, DCE, AND VINYL CHLORIDE IN WATER BY CALCULATING 95TH % U.C.L.

	Phase I Concentration (ug/L)			Phase II Concentration (ug/L)		
Well	TCE	1,2-DCE	Vinyl Chloride	TCE	1,2-DCE	Vinyl Chloride
TRENCH 1						
PT-12	180	195	4	970	1400	88
PT-20	25	24	5	37	53	5
PT-21	2	16	5	3	14	5
PT-22	80	100	5	98	150	5
MW-45				5	5	5
MW-46				47	120	5
TRENCH 2						
PT-17	260	53	7	190	43	5
PT-24	4	100	5	4	62	5
MW-27	2.5	2.5	5	0.25	0.25	0.25
MW-28	33	61	5	35	53	5
MW-29	1	71	5	2	97	5
MW-30	2.5	2.5	5	1	0.25	0.25
MW-31	2.5	2.5	5	0.25	0.25	0.25

	TCE		1,2-DCE		Vinyl Chloride	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Trench 1:	144.7	280.0	207.7	402.2	13.2	24.9
Trench 2:	38.4	78.1	39.2	35.9	4.1	2.1

ORDERED DATA

		TCE	1,2-DCE	Vinyl Chloride
Trench 1				
		2	5	4
k = 5		3	14	5
a(1)=	0.5739	5	16	5
a(2)=	0.3291	25	24	5
a(3)=	0.2141	37	53	5
a(4)=	0.1224	47	100	5
a(5)=	0.0399	80	120	5
		98	150	5
		180	195	5
		970	1400	88
Trench 2				
		0.25	0.25	0.25
k = 7		0.25	0.25	0.25
		1	0.25	0.25
a(1)=	0.5251	1	2.5	5
a(2)=	0.3318	2	2.5	5
a(3)=	0.246	2.5	2.5	5
a(4)=	0.1802	2.5	43	5
a(5)=	0.124	2.5	53	5
a(6)=	0.0727	4	53	5
a(7)=	0.024	4	61	5
		33	62	5
		35	71	5
		190	97	5
		260	100	7

TCE:
d = 784164.1
W = 0.523692 Non-normal
1,2-DCE:
d = 1617394
W = 0.503561 Non-normal

Vinyl chloride
d = 6217.6
W = 0.373773 Non-normal

TCE:
d = 84601.01
W = 0.540514 Non-normal

1,2-DCE:
d = 18031.08
W = 0.849619 Normal

Vinyl chloride
d = 60.96875
W = 0.648713 Non-normal

3/5

ESTIMATION OF UNCONTROLLED AIR EMISSIONS FROM AIR STRIPPER

1.) ESTIMATE CONCENTRATION OF TCE, DCE, AND VINYL CHLORIDE IN WATER
BY CALCULATING 95TH % U.C.L.
LOG DATA

	Phase I Concentration (ug/L)			Phase II Concentration (ug/L)		
Well	TCE	1,2-DCE	Vinyl Chloride	TCE	1,2-DCE	Vinyl Chloride
TRENCH 1						
PT-12	5.19	5.27	1.39	6.88	7.24	4.48
PT-20	3.22	3.18	1.61	3.61	3.97	1.61
PT-21	0.69	2.77	1.61	1.10	2.64	1.61
PT-22	4.38	4.61	1.61	4.58	5.01	1.61
MW-45				1.61	1.61	1.61
MW-46				3.85	4.79	1.61
TRENCH 2						
PT-17	5.56	3.97	1.95	5.25	3.76	1.61
PT-24	1.39	4.61	1.61	1.39	4.13	1.61
MW-27	0.92	0.92	1.61	-1.39	-1.39	-1.39
MW-28	3.50	4.11	1.61	3.56	3.97	1.61
MW-29	0.00	4.26	1.61	0.69	4.57	1.61
MW-30	0.92	0.92	1.61	0.00	-1.39	-1.39
MW-31	0.92	0.92	1.61	-1.39	-1.39	-1.39

	TCE		1,2-DCE		Vinyl Chloride	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Trench 1:	3.5	1.8	4.1	1.5	1.9	0.9
Trench 2:	1.5	2.1	2.3	2.3	1.0	1.2

ORDERED DATA – log data

		TCE	1,2-DCE	Vinyl Chloride		
Trench 1						
		0.693147	1.609437912	1.386294	TCE:	
k = 5		1.098612	2.63905733	1.609438	d =	33.6592
a(1)=	0.5739	1.609438	2.772588722	1.609438	W =	0.960361 Log-normal
a(2)=	0.3291	3.218876	3.17805383	1.609438	1,2-DCE:	
a(3)=	0.2141	3.610918	3.970291914	1.609438	d =	23.78447
a(4)=	0.1224	3.850148	4.605170186	1.609438	W =	0.969559 Lognormal
a(5)=	0.0399	4.382027	4.787491743	1.609438		
		4.584967	5.010635294	1.609438	Vinyl chloride	
		5.192957	5.272999559	1.609438	d =	7.575164
		6.877296	7.244227516	4.477337	W =	0.415423 Non-lognormal
Trench 2						
		-1.38629	-1.38629436	-1.38629	TCE:	
k = 7		-1.38629	-1.38629436	-1.38629	d =	20.9885
		0	-1.38629436	-1.38629	W =	2.661204 Lognormal
a(1)=	0.5251	0	0.916290732	1.609438		
a(2)=	0.3318	0.693147	0.916290732	1.609438	1,2-DCE:	
a(3)=	0.246	0.916291	0.916290732	1.609438	d =	75.17932
a(4)=	0.1802	0.916291	3.761200116	1.609438	W =	0.791804 Non-lognormal
a(5)=	0.124	0.916291	3.970291914	1.609438		
a(6)=	0.0727	1.386294	3.970291914	1.609438	Vinyl chloride	
a(7)=	0.024	1.386294	4.110873864	1.609438	d =	21.69109
		3.496508	4.127134385	1.609438	W =	0.558529 Non-lognormal
		3.555348	4.262679877	1.609438		
		5.247024	4.574710979	1.609438		
		5.560682	4.605170186	1.94591		

PARSONS MAIN, INC. PARSONS

CLIENT USACE JOB NO. 720447 SHEET 4 OF 5
SUBJECT SEDA Ash Landfill FS BY DMK DATE 1/4/94
CKD. REVISION

Estimate 95th% U.C.L. for normal distributions with "t" statistic

1,2 DCE - Trench 2

$$95^{th}\ U.C.L. = \bar{x} + t_{.95,13}\frac{s}{\sqrt{14}}$$

$$= 39.2 + 1.771\frac{35.9}{\sqrt{14}}$$

$$= 56.2$$

Estimate 95th% U.C.L. for lognormal distributions with

$$95^{th}\%\ UCL = \exp\left(\bar{y} + 0.5 s_y^2 + \frac{s_y H_{1-\alpha}}{\sqrt{n-1}}\right)$$

TCE - Trench 1

$$95^{th}\%\ UCL = \exp\left(3.5 + 0.5(1.8)^2 + \frac{(1.8)(4.8)}{\sqrt{9}}\right)$$

$$= 2981$$

t

307

TCE - Trench 2

$$95^{th}\%\ U.C.L. = \exp\left(4.5 + 0.5(2.1)^2 + \frac{(2.1)(.57)}{\sqrt{13}}\right)$$

$$= 748$$

t

75

CLIENT

SUBJECT

JOB NO. 720447 SHEET 5 OF 5

BY DMK DATE 1/4/94

CKD. REVISION

1,2 DCE - Trench 1

$$95^{th}\% \ UCL = \exp\left(4.1 + 0.5(1.5)^2 + \frac{(1.5)(4.2)}{\sqrt{9}}\right)$$

$$= 1518$$

Vinyl Chloride - Trench 1

$$95^{th}\% \ U.C.L = \exp\left(1.9 + 0.5(0.9)^2 + \frac{(0.9)(2.9)}{\sqrt{9}}\right)$$

$$= 24$$

Vinyl Chloride - Trench 2

$$95^{th}\% \ UCL = \exp\left(1.0 + (0.5)(1.2)^2 + \frac{(1.2)(3.3)}{\sqrt{13}}\right)$$

$$= 16.7$$

Design Concentration = Avg of Trench 1 & Trench 2

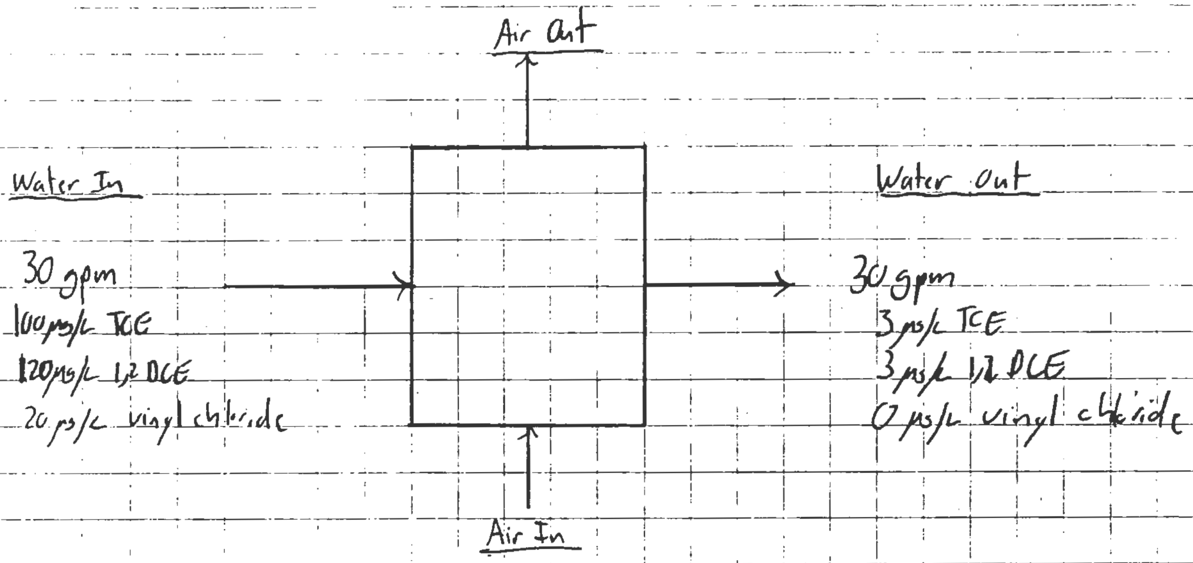
TCE = (2981 + 748)/2 = 1865 µg/L

1,2DCE = (1518 + 56.2)/2 = 787 µg/L

Vinyl Chloride = (24 + 16.7)/2 = 20 µg/L

CLIENT U.S.A.C.E. JOB NO. 720447 SHEET 1 OF 9
SUBJECT SEDA Ash Landfill FS BY DMK DATE 12/22/93
Air Emissions CKD. REVISION

Evaluate Air Emissions from Air Stripper



300 cfm - Shallow Tray
160 cfm - NES

Mass Balance on Contaminants in Water

Mass in − Mass Out = Mass Transfered

TCE $100\,\mu g/L \times 30\,\text{gal/min} \times 3.785\,\text{L/gal} - 3 \times 30 \times 3.785 = 11{,}014\,\mu g/\text{min}$
$= 0.00018\,\text{g/sec}$

V.C. $(20\,\mu/L)(30\,\text{gal/min})(3.785\,\text{L/gal})\left(\frac{1\,g}{10^6\,\mu g}\right)\left(\frac{1\,\text{min}}{60\,\text{sec}}\right) = 3.8 \times 10^{-5}\,\text{g/sec}$

1,2-DCE $(120\,\mu g/L \times 30\,\text{gal/min} - (3\,\mu g/L)(30\,\text{gal/min})\,3.785\,\text{L/gal} = 0.00022\,\text{g/s}$

CLIENT USACE
JOB NO. 720447 SHEET 2 OF 9
SUBJECT SEDA Ash Landfill FS
Air Emissions
BY DMK DATE 12/22/93
CKD. REVISION

SCREEN Results

5-foot stack - Shallow Tray

	Fenceline Conc (μg/m^3)	Fenceline Annual (μg/m^3)	Farmhouse Conc. (μg/m^3)	Farmhouse Annual (μg/m^3)	SGC	AGC
TCE	0.76	0.08	0.18	0.02	33,000	0.45
1,2 DCE	0.93	0.09	0.22	0.02	190,000	1900
Vinyl chloride	0.16	0.02	0.038	0.004	1300	0.02

10-foot stack - Shallow Tray

	Fenceline Conc (μg/m^3)	Fenceline Annual (μg/m^3)	Farmhouse Conc (μg/m^3)	Farmhouse Annual (μg/m^3)	SGC	AGC
TCE	0.54	0.05	0.17	0.02	33,000	0.45
1,2-DCE	0.66	0.07	0.21	0.02	190,000	1900
Vinyl Chloride	0.11	0.01	0.036	0.004	1300	0.02

29-foot stack - NES design

	Fenceline Conc. (μg/m^3)	Fenceline Annual (μg/m^3)	Farmhouse Conc. (μg/m^3)	Farmhouse Annual (μg/m^3)	SGC	AGC
TCE	0.19	0.02	0.13	0.01	33,000	0.45
1,2 DCE	0.23	0.02	0.16	0.02	190,000	1900
Vinyl Chloride	0.04	0.004	0.03	0.003	1300	0.02

PARSONS MAIN, INC. PARSONS

CLIENT USACE JOB NO. 720447 SHEET 1 OF 2
SUBJECT SEDA Ash Landfill FS BY DMK DATE 7/11/94
Air Emissions CKD. REVISION

Evaluate Air stripper emissions for case where removal action has not been completed

<u>Mass Balance on contaminants in water</u>

TCE $(500-3)\ \mu g/L \times 30\ \text{gal/min} \times 3.785\ \text{L/gal} \times \frac{1\ \text{min}}{60\ \text{sec}} = 940\ \mu g/\text{sec}$ →
$= 0.00094\ g/\text{sec}$

DCE $(725-3)\ \mu g/L \times 30 \times 3.785 \times \frac{1}{60}$ $= 1366\ \mu g/\text{sec}$
$= 0.0014\ g/\text{sec}$

VC $(44) \times 30 \times 3.765 \times 1/60$ $= 83.3\ \mu g/\text{sec}$
$= 0.00008\ g/\text{sec}$

SCREEN Results - results based on previous calcs. (12/22/93)

5-foot stack - Shallow Tray

	Fenceline Conc (µg/m3)	Fenceline Annual (µg/m3)	Farmhouse Conc (µg/m3)	Farmhouse Annual (µg/m3)	SGC	AGC
TCE	3.97	0.40	0.95	0.10	33,000	0.45
DCE	5.91	0.59	1.42	0.14	190,000	1900
VC	0.34	0.03	0.08	0.008	1300	0.02

10-foot stack Shallow Tray

	Fenceline Conc. (µg/m3)	Fenceline Annual (µg/m3)	Farmhouse Conc. (µg/m3)	Farmhouse Annual (µg/m3)	SGC	AGC
TCE	2.82	0.28	0.89	0.09	33,000	0.45
DCE	4.20	0.42	1.33	0.13	190,000	1900
VC	0.24	0.02	0.08	0.008	1300	0.02

PARSONS MAIN, INC. **PARSONS**

CLIENT USACE JOB NO. 720447 SHEET 2 OF 2

SUBJECT SEDA Ash Landfill FS BY DMK DATE 7/11/94

Air Emissions CKD. REVISION

29-foot stack NES design

	Fenceline Conc. (µg/m³)	Fenceline Annual (µg/m³)	Farmhouse Conc. (µg/m³)	Farmhouse Annual (µg/m³)	SGC	AGC
TCE	1.00	0.10	0.66	0.07	33,000	0.45
DCE	1.50	0.15	0.99	0.10	190,000	1900
VC	0.09	0.009	0.06	0.006	1300	0.02

stack height = 5 feet

3/9

Shallow Tray

```
                                                                   12/22/93
                                                                   14:29:10
  ** SCREEN2 MODEL RUN ***
  ** VERSION DATED 92245 ***

Senecca 12/22/93

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE             =       POINT
   EMISSION RATE (G/S)     =     .180000E-03
   STACK HEIGHT (M)        =      1.5240
   STK INSIDE DIAM (M)     =       .1524
   STK EXIT VELOCITY (M/S)=       7.7617
   STK GAS EXIT TEMP (K)   =     283.0000
   AMBIENT AIR TEMP (K)    =     293.0000
   RECEPTOR HEIGHT (M)     =       .0000
   URBAN/RURAL OPTION      =       RURAL
   BUILDING HEIGHT (M)     =       .0000
   MIN HORIZ BLDG DIM (M)  =       .0000
   MAX HORIZ BLDG DIM (M)  =       .0000

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =   300.00000     (ACFM)
TA > TS!!!  BUOY. FLUX SET = 0.0

BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .350 M**4/S**2.

*** FULL METEOROLOGY ***

  *******************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    2. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST      CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------    ----  -----  -----  ------  ------  ------  ------  -----

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST      CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------    ----  -----  -----  ------  ------  ------  ------  -----
   250.   .7611          6     1.0    1.0 10000.0    4.78    9.54    4.96    NO
   730.   .1825          6     1.0    1.0 10000.0    4.78   25.43   11.29    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  WASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
   ASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *********************************************
 *  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR  *
```

4/9

```
 *    SIMPLE ELEVATED TERRAIN PROCEDURE     *
 ********************************************

      TERRAIN        DISTANCE RANGE (M)
       HT (M)       MINIMUM    MAXIMUM
      -------      --------   --------
          0.          250.        --
          0.          730.        --

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC    DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
--------------     -----------   -------   -------
SIMPLE TERRAIN       .7611         250.        0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

5/9

```
                                                                      12/22/93
                                                                      14:31:47
 *** SCREEN2 MODEL RUN ***
 *** VERSION DATED 92245 ***

Senecca 12/22/93 - Stack Height = 10 Feet

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =        POINT
   EMISSION RATE (G/S)      =      .180000E-03
   STACK HEIGHT (M)         =       3.0480
   STK INSIDE DIAM (M)      =        .1524
   STK EXIT VELOCITY (M/S)=         7.7617
   STK GAS EXIT TEMP (K)    =     283.0000
   AMBIENT AIR TEMP (K)     =     293.0000
   RECEPTOR HEIGHT (M)      =        .0000
   URBAN/RURAL OPTION       =        RURAL
   BUILDING HEIGHT (M)      =        .0000
   MIN HORIZ BLDG DIM (M) =          .0000
   MAX HORIZ BLDG DIM (M) =          .0000

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    300.00000     (ACFM)
TA > TS!!!  BUOY. FLUX SET = 0.0

BUOY. FLUX =      .000 M**4/S**3;  MOM. FLUX =      .350 M**4/S**2.

*** FULL METEOROLOGY ***

  **********************************
*** SCREEN DISCRETE DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    2. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST      CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------    ----  -----  -----  ------  ------  ------  ------  -----

**********************************
*** SCREEN DISCRETE DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST      CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------    ----  -----  -----  ------  ------  ------  ------  -----
   250.   .5402          6     1.0    1.0 10000.0    6.30    9.54    4.96    NO
   730.   .1708          6     1.0    1.0 10000.0    6.30   25.43   11.29    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  WASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
  WASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 ********************************************
 *  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR   *
```

Shallow Tray

6/9

```
 *    SIMPLE ELEVATED TERRAIN PROCEDURE     *
 ********************************************

      TERRAIN        DISTANCE RANGE (M)
       HT (M)       MINIMUM    MAXIMUM
      -------      --------   --------
           0.          250.        --
           0.          730.        --

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION           MAX CONC     DIST TO    TERRAIN
  PROCEDURE           (UG/M**3)     MAX (M)     HT (M)
--------------       -----------    -------    -------
SIMPLE TERRAIN        .5402            250.         0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

7/9

```
                                                                    01/05/94
                                                                    10:29:13
   **  SCREEN2 MODEL RUN  ***
   ** VERSION DATED 92245 ***

Seneca 1/5/1994 St. Height = 29 Feet
```

NES

```
SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =        POINT
   EMISSION RATE (G/S)      =      .180000E-03
   STACK HEIGHT (M)         =      8.8392
   STK INSIDE DIAM (M)      =       .1524
   STK EXIT VELOCITY (M/S)=        4.1396
   STK GAS EXIT TEMP (K)    =    293.0000
   AMBIENT AIR TEMP (K)     =    293.0000
   RECEPTOR HEIGHT (M)      =       .0000
   URBAN/RURAL OPTION       =        RURAL
   BUILDING HEIGHT (M)      =       .0000
   MIN HORIZ BLDG DIM (M) =         .0000
   MAX HORIZ BLDG DIM (M) =         .0000

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    160.00000     (ACFM)

BUOY. FLUX =      .000 M**4/S**3;  MOM. FLUX =      .099 M**4/S**2.

*** FULL METEOROLOGY ***

  *********************************
  * SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST      CONC               U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)    STAB   (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)   DWASH
-------  ----------    ----   -----  -----  ------   ------  ------  ------   -----
   250.    .1923         5     1.0     1.0 10000.0    10.73   14.29    7.51    NO
   730.    .1271         6     1.0     1.0 10000.0    10.73   25.42   11.26    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 ********************************************
 *  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR  *
 *    SIMPLE ELEVATED TERRAIN PROCEDURE     *
 ********************************************

      TERRAIN        DISTANCE RANGE (M)
       HT (M)       MINIMUM     MAXIMUM
      -------      --------    --------
          0.          250.        --
          0.          730.        --

     **************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
```

8/9

```
                                                                        01/05/94
                                                                        10:29:13
  **  SCREEN2 MODEL RUN  ***
 ** VERSION DATED 92245 ***

Seneca 1/5/1994 St. Height = 29 Feet

COMPLEX TERRAIN INPUTS:
   SOURCE TYPE              =        POINT
   EMISSION RATE (G/S)      =      .180000E-03
   STACK HT (M)             =       8.8392
   STACK DIAMETER (M)       =        .1524
   STACK VELOCITY (M/S)     =       4.1396
   STACK GAS TEMP (K)       =     293.0000
   AMBIENT AIR TEMP (K)     =     293.0000
   RECEPTOR HEIGHT (M)      =        .0000
   URBAN/RURAL OPTION       =        RURAL

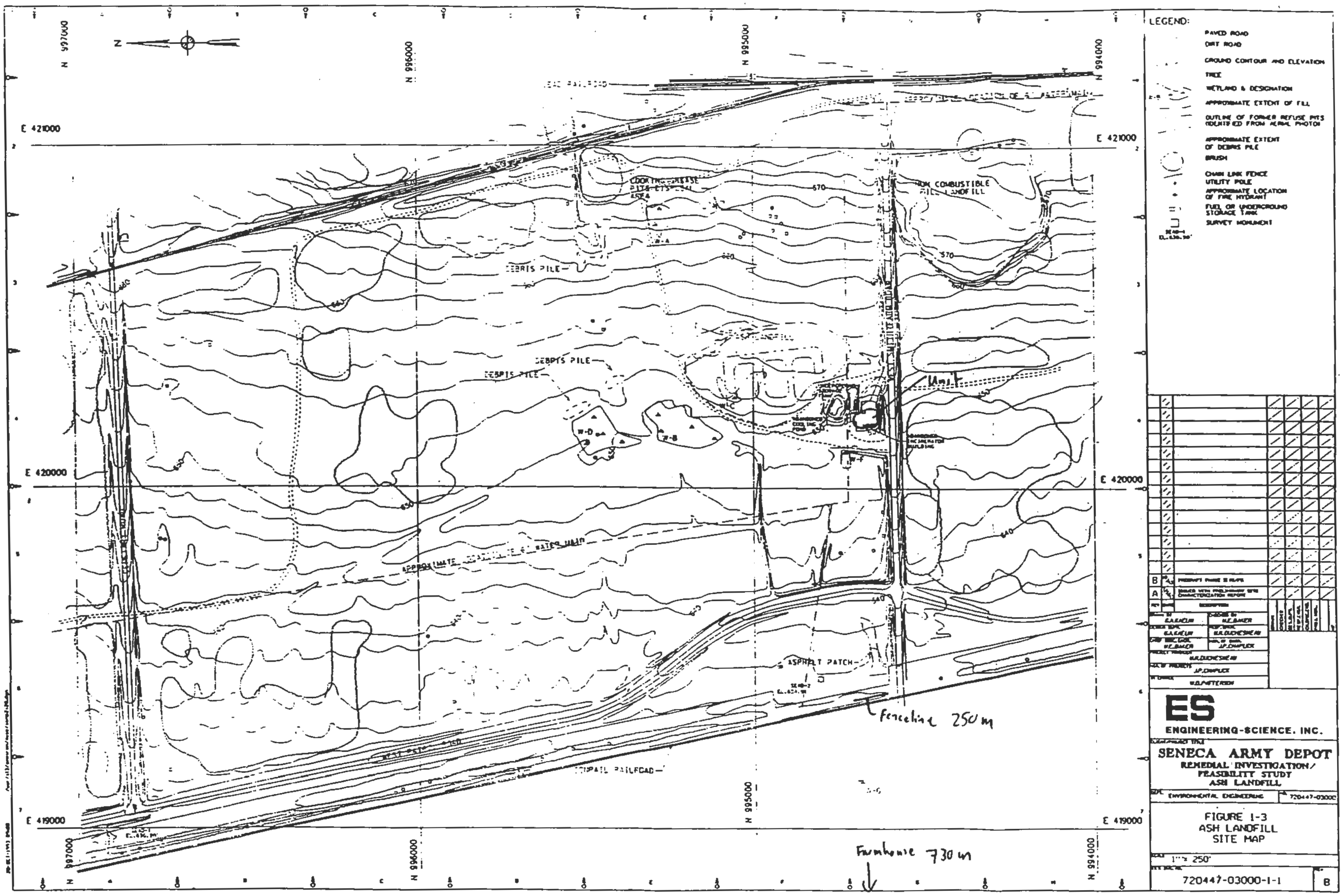

BUOY. FLUX =      .000 M**4/S**3;  MOM. FLUX =      .099 M**4/S**2.


FINAL STABLE PLUME HEIGHT (M) =    9.6
DISTANCE TO FINAL RISE (M)    =  151.3
```

```
     ****************************************

 CALCULATION          MAX CONC    DIST TO   TERRAIN
  PROCEDURE          (UG/M**3)    MAX (M)    HT (M)
  ------------      -----------   -------   -------
SIMPLE TERRAIN        .1923         250.        0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```



Unit

Fenceline 250 m

Farmhouse 730 m

REV	DATE	DESCRIPTION
B		PRELIMINARY PHASE II RI/FS
A		ISSUED WITH PRELIMINARY SITE CHARACTERIZATION REPORT

DRAWN BY G.A.KAELIN — CHECKED BY W.E.BAKER

DESIGN SUPV. G.A.KAELIN — PROJ. SUPV. W.R.DUCHESNEAU

CHIEF ENG. W.E.BAKER — MGR. OF ENGR. J.P.CHMPLICK

PROJECT MANAGER W.R.DUCHESNEAU

MGR. OF PROJECTS J.P.CHMPLICK

IN CHARGE W.D.PATTERSON

ES

ENGINEERING-SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT

REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
ASH LANDFILL

ENVIRONMENTAL ENGINEERING — 720447-03000

FIGURE 1-3
ASH LANDFILL
SITE MAP

SCALE 1" = 250'

FILE NO. 720447-03000-1-1 — REV. B

Calculation of Air Emissions During Source Removal Excavation

ES ENGINEERING-SCIENCE, INC.

lient Seneca Army Depot
ubject Ash Landfill Removal Action
Air Emissions During Excavation
Job No. 720489-01000
By DMK
Checked
Sheet 1 of 45
Date 9/28/93
Rev.

Estimate Air Emissions from Excavation of Contaminated Soil at the Bend-in-the-Road Area

Step I - estimate soil emissions
Step II - Use SCREEN model to estimate concentrations at receptors

Step I

Use EPA model LAND7 to estimate emission rates

Note - This model assumes tilling. According to EPA 450/1-89-003 (p. 106) the agitation factor for tilling is comparable to that for excavation.

Check - use CRI emission model for vinyl chloride

Results: LAND7 : 2.83×10^{-6} (1st day) 1.41×10^{-5} (1st 15 minutes)
($g/s \cdot m^2$) CRI : 1.77×10^{-6}

∴ Models are comparable

Step II
- Use LAND7 output as input to SCREEN model
- Also look at 10x and 100x LAND7 emission rates

Assumptions
1) 400 yd^3/day excavation rate ⇒ 150 m^2 a size of area source
2) Look at 200 ft and fenceline as receptors
3) Use peak (15-minute) emission rates for maximum concentrations (SGC)
4) Use long term emission rates for annual concentrations (AGC)

Seneca Army Depot
Air Contaminant Predicted Concentrations
Screen2 Model Results – Short and Long Term Emission Rates
Measured Concentrations

Compound	Short Term Emission Rate 1st Day (g/s–m2)	Max. 24–Hour Predicted Concentration (ug/m3)	Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)	Peak Emission Rate 1st 15 Min. (g/s–m2)	Max. 24–Hour Predicted Concentration (ug/m3)	Max. 24–Hour Predicted Concentration (ppmv)	Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)	N.Y. SGC (ug/m3)
Vinyl Chloride	2.83E–06	4.79	0.69	1.41E–05	23.86	0.0086	3.46	1300
Acetone	4.68E–07	0.79	0.11	2.28E–06	3.86	0.0015	0.56	140,000
Carbon disulfide	2.12E–07	0.36	0.05	1.03E–06	1.74	0.0005	0.25	710
1,1 Dichlorethene	2.40E–07	0.41	0.06	1.17E–06	1.98	0.0005	0.29	2,000
1,2 Dichlorethene (Total)	6.33E–06	10.71	1.55	3.08E–05	52.13	0.0120	7.55	190,000
Chloroform	1.14E–08	0.02	0.00	5.56E–08	0.09	0.0000	0.01	980
1,2 Dichlorethane	9.25E–08	0.16	0.02	4.48E–07	0.76	0.0002	0.11	950
2–Butanone	9.45E–09	0.02	0.00	4.58E–08	0.08	0.0000	0.01	140,000
Trichloroethene	2.22E–05	37.57	5.44	1.07E–04	181.09	0.0309	26.22	33,000
Benzene	2.51E–09	0.004	0.00	1.22E–08	0.02	0.0000	0.00	30
Tetrachloroethene	1.01E–09	0.002	0.00	4.85E–09	0.01	0.0000	0.00	81,000
Toluene	1.50E–07	0.25	0.04	7.20E–07	1.22	0.0003	0.18	89,000
Chlorobenzene	8.02E–08	0.14	0.02	3.82E–07	0.65	0.0001	0.09	11,000
Ethylbenzene	4.52E–08	0.08	0.01	2.14E–07	0.36	0.0001	0.05	100,000
Xylene	2.16E–07	0.37	0.05	1.02E–06	1.73	0.0004	0.25	100,000
						0.055		5 ppmv

Compound	Long Term Emission Rate (g/s–m2)	Max. 24–Hour Predicted Concentration (ug/m3)	Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)	N.Y. AGC (ug/m3)
Vinyl Chloride	1.13E–08	0.0038	0.0006	0.02
Acetone	5.35E–09	0.0018	0.0003	14000
Carbon disulfide	2.26E–09	0.0008	0.0001	7
1,1 Dichlorethene	2.29E–09	0.0008	0.0001	0.02
1,2 Dichlorethene (Total)	1.08E–07	0.0367	0.0053	1900
Chloroform	1.61E–10	0.0001	0.0000	23
1,2 Dichlorethane	2.11E–09	0.0007	0.0001	0.039
2–Butanone	2.18E–10	0.0001	0.0000	300
Trichloroethene	5.98E–07	0.2024	0.0293	0.45
Benzene	5.69E–11	0.0000	0.0000	0.12
Tetrachloroethene	4.83E–11	0.0000	0.0000	0.075
Toluene	5.85E–09	0.0020	0.0003	2000
Chlorobenzene	4.07E–09	0.0014	0.0002	20
Ethylbenzene	2.32E–09	0.0008	0.0001	1000
Xylene	1.11E–08	0.0038	0.0005	300

Notes:

1 Maximum predicted concentration occured at a receptor located 200 feet from the nearest edge of the area source

2 Nearest Fenecelne receptor is located 260 meters (853 feet) east of the aproximate location of the nearest edge of the area source

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03–May–94

Seneca Army Depot
Air Contaminant Predicted Concentrations

Screen2 Model Results – Short and Long Term Emission Rates
10 Times Measured Concentrations

Compound	Short Term Emission Rate 1st Day (g/s–m2)	Max. 24–Hour Predicted Concentration (ug/m3)	Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)	Peak Emission Rate 1st 15 Min. (g/s–m2)	Max. 24–Hour Predicted Concentration (ug/m3)	Max. 24–Hour Predicted Concentration (ppmv)	Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)	N.Y. SGC (ug/m3)
Vinyl Chloride	2.83E–05	47.89	6.93	1.41E–04	238.63	0.0855	34.55	1300
Acetone	4.68E–06	7.92	1.15	2.28E–05	38.59	0.0149	5.59	140,000
Carbon disulfide	2.12E–06	3.59	0.52	1.03E–05	17.43	0.0050	2.52	710
1,1 Dichlorethene	2.40E–06	4.06	0.59	1.17E–05	19.80	0.0046	2.87	2,000
1,2 Dichlorethene (Total)	6.33E–05	107.13	15.51	3.08E–04	521.26	0.1204	75.47	190,000
Chloroform	1.14E–07	0.19	0.03	5.56E–07	0.94	0.0002	0.14	980
1,2 Dichlorethane	9.25E–07	1.57	0.23	4.48E–06	7.58	0.0017	1.10	950
2–Butanone	9.45E–08	0.16	0.02	4.58E–07	0.78	0.0002	0.11	140,000
Trichloroethene	2.22E–04	375.71	54.40	1.07E–03	1810.87	0.3087	262.19	33,000
Benzene	2.51E–08	0.042	0.01	1.22E–07	0.21	0.0001	0.03	30
Tetrachloroethene	1.01E–08	0.017	0.00	4.85E–08	0.08	0.0000	0.01	81,000
Toluene	1.50E–06	2.54	0.37	7.20E–06	12.19	0.0030	1.76	89,000
Chlorobenzene	8.02E–07	1.36	0.20	3.82E–06	6.46	0.0013	0.94	11,000
Ethylbenzene	4.52E–07	0.76	0.11	2.14E–06	3.62	0.0008	0.52	100,000
Xylene	2.16E–06	3.66	0.53	1.02E–05	17.26	0.0036	2.50	100,000
						0.550		5 ppmv

Compound	Long Term Emission Rate (g/s–m2)	Max. 24–Hour Predicted Concentration (ug/m3)	Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)	N.Y. AGC (ug/m3)
Vinyl Chloride	1.13E–07	0.0383	0.0055	0.02
Acetone	5.35E–08	0.0181	0.0026	14000
Carbon disulfide	2.26E–08	0.0076	0.0011	7
1,1 Dichlorethene	2.29E–08	0.0077	0.0011	0.02
1,2 Dichlorethene (Total)	1.08E–06	0.3670	0.0531	1900
Chloroform	1.61E–09	0.0005	0.0001	23
1,2 Dichlorethane	2.11E–08	0.0071	0.0010	0.039
2–Butanone	2.18E–09	0.0007	0.0001	300
Trichloroethene	5.98E–06	2.0241	0.2931	0.45
Benzene	5.69E–10	0.0002	0.0000	0.12
Tetrachloroethene	4.83E–10	0.0002	0.0000	0.075
Toluene	5.85E–08	0.0198	0.0029	2000
Chlorobenzene	4.07E–08	0.0138	0.0020	20
Ethylbenzene	2.32E–08	0.0078	0.0011	1000
Xylene	1.11E–07	0.0377	0.0055	300

Notes:

1 Maximum predicted concentration occured at a receptor located 200 feet from the nearest edge of the area source

2 Nearest Fenceline receptor is located 260 meters (853 feet) east of the aproximate location of the nearest edge of the area source

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Seneca Army Depot
Air Contaminant Predicted Concentrations
Screen2 Model Results – Short and Long Term Emission Rates
100 Times Measured Concentrations

Compound	**Short Term Emission Rate 1st Day (g/s–m2)**	**Max. 24–Hour Predicted Concentration (ug/m3)**	**Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)**	**Peak Emission Rate 1st 15 Min. (g/s–m2)**	**Max. 24–Hour Predicted Concentration (ug/m3)**	**Max. 24–Hour Predicted Concentration (ppmv)**	**Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)**	**N.Y. SGC (ug/m3)**
Vinyl Chloride	2.83E–04	478.95	69.35	1.41E–03	2386.28	0.8552	345.51	1300
Acetone	4.68E–05	79.20	11.47	2.28E–04	385.87	0.1490	55.87	140,000
Carbon disulfide	2.12E–05	35.88	5.19	1.03E–04	174.32	0.0500	25.24	710
1,1 Dichlorethene	2.40E–05	40.62	5.88	1.17E–04	198.01	0.0457	28.67	2,000
1,2 Dichlorethene (Total)	6.33E–04	1071.29	155.11	3.08E–03	5212.59	1.2037	754.72	190,000
Chloroform	1.14E–06	1.93	0.28	5.56E–06	9.41	0.0018	1.36	980
1,2 Dichlorethane	9.25E–06	15.65	2.27	4.48E–05	75.82	0.0172	10.98	950
2–Butanone	9.45E–07	1.60	0.23	4.58E–06	7.75	0.0024	1.12	140,000
Trichloroethene	2.22E–03	3757.13	543.99	1.07E–02	18108.68	3.0870	2621.93	33,000
Benzene	2.51E–07	0.425	0.06	1.22E–06	2.06	0.0006	0.30	30
Tetrachloroethene	1.01E–07	0.171	0.02	4.85E–07	0.82	0.0001	0.12	81,000
Toluene	1.50E–05	25.39	3.68	7.20E–05	121.85	0.0295	17.64	89,000
Chlorobenzene	8.02E–06	13.57	1.97	3.82E–05	64.65	0.0129	9.36	11,000
Ethylbenzene	4.52E–06	7.65	1.11	2.14E–05	36.22	0.0076	5.24	100,000
Xylene	2.16E–05	36.56	5.29	1.02E–04	172.62	0.0364	24.99	100,000
						5.499		5 ppmv

Compound	**Long Term Emission Rate (g/s–m2)**	**Max. 24–Hour Predicted Concentration (ug/m3)**	**Predicted 24–Hour Concentration at Nearest Fenceline Point (ug/m3)**	**N.Y. AGC (ug/m3)**
Vinyl Chloride	1.13E–06	0.3829	0.0554	0.02
Acetone	5.35E–07	0.1812	0.0262	14000
Carbon disulfide	2.26E–07	0.0764	0.0111	7
1,1 Dichlorethene	2.29E–07	0.0774	0.0112	0.02
1,2 Dichlorethene (Total)	1.08E–05	3.6696	0.5313	1900
Chloroform	1.61E–08	0.0055	0.0008	23
1,2 Dichlorethane	2.11E–07	0.0713	0.0103	0.039
2–Butanone	2.18E–08	0.0074	0.0011	300
Trichloroethene	5.98E–06	2.0241	0.2931	0.45
Benzene	5.69E–09	0.0019	0.0003	0.12
Tetrachloroethene	4.83E–09	0.0016	0.0002	0.075
Toluene	5.85E–07	0.1980	0.0287	2000
Chlorobenzene	4.07E–07	0.1379	0.0200	20
Ethylbenzene	2.32E–07	0.0784	0.0113	1000
Xylene	1.11E–06	0.3769	0.0546	300

Notes:

1 Maximum predicted concentration occured at a receptor located 200 feet from the nearest edge of the area source

2 Nearest Feneceline receptor is located 260 meters (853 feet) east of the aproximate location of the nearest edge of the area source

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                                                                    09/27/93
                                                                    16:12:50
   *  SCREEN2 MODEL RUN   ***
  *** VERSION DATED 92245 ***

Seneca Army Depot Toxic Chemicals Screening

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                  =        AREA
   EMISSION RATE (G/(S-M**2))   =     1.00000
   SOURCE HEIGHT (M)            =       .0000
   LENGTH OF SIDE (M)           =     10.0000
   RECEPTOR HEIGHT (M)          =       .0000
   URBAN/RURAL OPTION           =       RURAL


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
 -----  ----------    ----  -----  -----  ------  ------  ------  ------  -----
  100.   .2515E+07     6      1.0    1.0 10000.0     .00    3.86    2.41    NO
  200.   .9283E+06     6      1.0    1.0 10000.0     .00    7.53    4.16    NO
  300.   .4857E+06     6      1.0    1.0 10000.0     .00   11.04    5.69    NO
  400.   .3023E+06     6      1.0    1.0 10000.0     .00   14.45    7.11    NO
  500.   .2083E+06     6      1.0    1.0 10000.0     .00   17.78    8.45    NO
  600.   .1534E+06     6      1.0    1.0 10000.0     .00   21.05    9.74    NO
  700.   .1184E+06     6      1.0    1.0 10000.0     .00   24.28   10.98    NO
  800.   .9577E+05     6      1.0    1.0 10000.0     .00   27.46   12.02    NO
  900.   .7942E+05     6      1.0    1.0 10000.0     .00   30.60   13.02    NO
 1000.   .6718E+05     6      1.0    1.0 10000.0     .00   33.71   13.99    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
  100.   .2515E+07     6      1.0    1.0 10000.0     .00    3.86    2.41    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------   ----  -----  -----  ------  ------  ------  ------  -----
   61.   .4233E+07     6      1.0    1.0 10000.0     .00    2.35    1.64    NO
```

```
  260.   .6126E+06    6     1.0     1.0 10000.0     .00    9.65     5.09    NO

  WASH=   MEANS NO CALC MADE (CONC = 0.0)
  WASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION          MAX CONC    DIST TO   TERRAIN
  PROCEDURE          (UG/M**3)    MAX (M)    HT (M)
--------------     -----------   -------   -------
SIMPLE TERRAIN       .4233E+07       61.        0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

7/45
EPA - 450/1-89-003
January 1989

Air/Superfund

EPA

AIR / SUPERFUND NATIONAL TECHNICAL GUIDANCE STUDY SERIES

Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites

Interim Final

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TABLE 27. INCREASE IN EMISSIONS DUE TO SOILS HANDLING

Soils Handling Category	Agitation Factor[a]	Reference
Excavation		
Backhoe	2.5-28	50
Dragline	-	
Scraper	-	
Bulldozer	36-63	51
Transport		
Conveyor Belt	36	51
Truck	-	
Dumping[b]	42-72	51
Storage		
Short-term[c]	10	51
Long-term	1	Assumed
Stabilization	-	
Grading[d]	4 (2-9)	52
	2.5-38	53

[a] Multiply agitation factor by baseline emissions estimate (BEE) to calculate VOC emission factor.

[b] Values from crushing of ore.

[c] <4 days.

[d] Values from tilling of waste.

- = No data available

1.1.1.1. From Soil Surface

ref. is Mackay & Matsugu 1973

description	units	variable		value	allowed range	typical value
<<------------- Output ----------->>						
mass flux per unit area	(moles/m²–hr)	Q/Ac	=	1.02E–04	= 1.77×10^{-6} g/m²-s	
<<------------- Input Variables -->>						
windspeed	m/hr	U	=	16092		
pool diameter or diameter of waste boundary	m	Dp	=	1		
Schmidt gas number	–	Sc	=	1.33		
vapor press of the vol at the surface	atm	P	=	0.0001		
pool temperature or temp of waste surface	°K	Tp	=	293		293°K
dist from soil surface down to surface of waste at time 0	m	ho	=	0		0 at surface
Henry's law constant	m³–atm/mol	H	=	0.086		
length of time waste at present location	hr	t	=	1		
air diffusion coeff of contaminant	m²/hr	Do	=	0.0382		
soil type constant	–	gamma	=	0.9	0.8 ■ gamma ■ 1.0	
total porosity	–	epsln_t	=	0.45	0 ■ epsln_t ■ 1	
air filled porosity	–	epsln_a	=	0.4		
soil type constant	–	μ	=	2.6		
<<------------- Intermediates (auto–calcs) ----------->>						
vapor phase mass transfer coeff into air	m/hr	ka	=	46.08		
vapor phase mass transfer coeff through soil	m/hr	ks	=	2.46E–02		
effective diffusion coeff of contaminant	m²/hr	De	=	0.00		
dist from soil surface down to surface of waste at time t	m	h	=	0.18		
overall mass transfer coeff	m/hr	k	=	0.024550734261		
<<------------- Constants ----------->>						
vapor press of the vol in the atmosphere	atm	P_inf	=	0		
gas constant	atm–m³/mole–°K	R	=	8.21E–05		

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COMPOUND	COUNT	AVERAGE	STD.DEV	95%ile	COEF OF VARIATION	NORMAL?

COMPOUND	COUNT	AVERAGE	STD.DEV	95%ile	COEF OF VARIATION	NORMAL?
VOCs						
Vinyl Chloride	66	436.96	1792.10	799.84	4.10	NOT NORMAL
Acetone	66	258.69	592.90	378.74	2.29	NOT NORMAL
Carbon Disulfide	65	117.34	207.63	159.70	1.77	NOT NORMAL
1,1-Dichloroethene	65	119.33	207.29	161.63	1.74	NOT NORMAL
1,2-Dichloroethene (total)	66	5095.05	12707.04	7668.05	2.49	NOT NORMAL
Chloroform	50	9.70	8.06	11.58	0.83	
1,2-Dichloroethene	65	108.94	197.25	149.19	1.81	NOT NORMAL
2-Butanone	50	13.44	9.96	16.76	0.74	
Trichloroethene	65	23764.62	91096.36	42351.56	3.83	NOT NORMAL
Benzene	11	3.27	0.90	3.72	0.28	
Tetrachloroethene	11	3.46	1.21	4.06	0.35	
Toluene	66	260.14	841.28	430.48	3.23	NOT NORMAL
Chlorobenzene	66	224.41	873.47	401.27	3.89	NOT NORMAL
Ethylbenzene	66	170.02	358.46	242.61	2.11	NOT NORMAL
Xylene (total)	66	732.07	2749.52	1288.81	3.76	NOT NORMAL
SEMIVOLATILES						
Phenol	70	515.43	1646.62	839.02	3.19	NOT NORMAL
2-Nitrophenol	70	334.00	221.30	377.61	0.66	
Benzoic acid	4	518.50	665.20	1188.69	1.28	NOT NORMAL
Naphthalene	70	407.50	518.86	509.62	1.27	NOT NORMAL
2-Methylnaphthalene	70	514.11	754.65	662.47	1.47	NOT NORMAL
Acenaphthylene	49	219.06	95.37	241.47	0.44	
Acenaphthene	70	334.81	287.22	391.29	0.86	
4-Nitrophenol	42	558.24	330.11	642.03	0.59	
Dibenzofuran	71	865.37	4479.03	1739.79	5.18	NOT NORMAL
2,4-Dinitrotoluene	70	344.71	279.30	399.63	0.81	
Fluorene	70	344.81	291.04	402.04	0.84	
N-Nitrosodiphenylamine (1)	37	193.65	22.29	199.68	0.12	
Phenanthrene	70	360.56	347.79	428.94	0.96	
Anthracene	70	333.76	289.72	390.72	0.87	
Di-n-butylphthalate	70	327.86	291.49	385.17	0.89	
Fluoranthene	70	372.90	374.10	446.46	1.00	NOT NORMAL
Pyrene	70	340.10	363.99	411.67	1.07	NOT NORMAL
Benzo(a)anthracene	70	348.26	302.50	407.73	0.87	
Chrysene	70	329.65	302.27	388.98	0.92	
bis(2-Ethylhexyl)phthalate	70	396.69	322.07	462.01	0.81	
Di-n-octylphthalate	39	175.00	55.01	189.49	0.31	
Benzo(b)fluoranthene	70	349.83	299.91	408.80	0.86	
benzo(k)fluoranthene	70	331.86	295.07	389.87	0.89	
Benzo(a)pyrene	70	337.80	295.82	395.96	0.88	
Indeno(1,2,3-cd)pyrene	70	329.64	288.65	386.30	0.88	
Dibenz(a,h)anthracene	70	332.01	285.61	388.17	0.86	
Benzo(g,h,i)perylene	70	318.13	291.34	376.41	0.92	

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COMPOUND	COUNT	AVERAGE	STD.DEV	95%ile	COEF OF VARIATION	NORMAL?
PESTICIDES/PCBs						
Heptachlor	77	5.73	4.02	6.48	0.70	
Dieldrin	77	11.45	8.10	12.97	0.71	
4,4'-DDE	77	22.58	39.76	30.04	1.76	NOT NORMAL
4,4'-DDD	77	14.44	11.71	16.64	0.81	
4,4'-DDT	77	16.51	22.33	20.69	1.35	NOT NORMAL
Aroclor-1242	70	59.90	37.71	67.32	0.63	
Aroclor-1260	77	172.29	148.03	200.04	0.86	
HERBICIDES						
2,4-DB	61	38.93	56.00	60.72	1.44	NOT NORMAL
2,4,5-TP (Silvex)	61	2.89	0.18	2.93	0.06	
MCPP	61	2906.20	167.13	2943.40	0.06	
METALS						
Aluminum	61	14913.61	3284.96	15606.49	0.22	
Antimony	61	3.83	1.68	4.19	0.44	
Arsenic	61	5.28	5.53	6.44	1.05	NOT NORMAL
Barium	61	79.38	31.65	86.02	0.40	
Beryllium	40	0.68	0.15	0.72	0.22	
Cadmium	61	1.70	1.60	2.04	0.94	
Calcium	61	32106.03	35634.07	39592.24	1.11	NOT NORMAL
Chromium	61	23.83	4.40	24.75	0.18	
Cobalt	61	12.35	2.73	12.93	0.22	
Copper	61	29.04	18.96	33.04	0.65	
Iron	61	29121.31	6483.91	30486.96	0.22	
Lead	69	43.06	95.63	63.64	2.22	NOT NORMAL
Magnesium	61	7408.20	2972.29	8034.22	0.40	
Manganese	61	656.69	286.17	716.96	0.44	
Mercury	67	0.06	0.11	0.09	1.76	NOT NORMAL
Nickel	61	36.18	7.83	37.81	0.22	
Potassium	61	1586.41	447.02	1680.66	0.28	
Selenium	61	0.30	0.35	0.37	1.17	NOT NORMAL
Silver	61	0.47	0.24	0.52	0.51	
Sodium	60	118.28	97.60	138.99	0.82	
Vanadium	57	21.71	4.41	22.67	0.20	
Zinc	61	300.23	689.36	445.42	2.30	NOT NORMAL
Cyanide	61	0.34	0.14	0.37	0.41	

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09/23/93

COMPOUND	COUNT	AVERAGE	STD.DEV	95%ile	COEF OF VARIATION	NORMAL?
VOCs						
Vinyl Chloride	66	436.96	1792.10	799.84	4.10	NOT NORMAL
Chloroethane	0	ERR	ERR	3.00	0.00	
Acetone	66	258.69	592.90	378.74	2.29	NOT NORMAL
Carbon Disulfide	65	117.34	207.63	159.70	1.77	NOT NORMAL
1,1-Dichloroethane	65	119.33	207.29	161.63	1.74	NOT NORMAL
1,2-Dichloroethene (total)	66	5095.05	12707.04	7668.05	2.49	NOT NORMAL
Chloroform	50	9.70	8.06	11.58	0.83	
1,2-Dichloroethane	65	108.94	197.25	149.19	1.81	NOT NORMAL
2-Butanone	50	13.44	9.86	15.76	0.74	
1,1,1-Trichloroethane	0	ERR	ERR	3.00	0.00	
Trichloroethene	65	23764.52	91096.36	42351.56	3.83	NOT NORMAL
Benzene	11	3.27	0.90	3.72	0.28	
Tetrachloroethene	11	3.45	1.21	4.06	0.35	
Toluene	66	260.14	841.28	430.48	3.23	NOT NORMAL
Chlorobenzene	66	224.41	873.47	401.27	3.89	NOT NORMAL
Ethylbenzene	66	170.02	358.46	242.61	2.11	NOT NORMAL
Xylene (total)	66	732.07	2749.52	1288.81	3.76	NOT NORMAL
SEMIVOLATILES						
Phenol	70	515.43	1645.82	839.02	3.19	NOT NORMAL
bis(2-Chloroethyl) ether	0	ERR	ERR	9.00	0.00	
2-Nitrophenol	70	334.00	221.30	377.51	0.66	
Benzoic acid	4	518.50	665.20	1188.69	1.28	NOT NORMAL
Naphthalene	70	407.60	518.86	509.52	1.27	NOT NORMAL
2-Methylnaphthalene	70	514.11	754.65	662.47	1.47	NOT NORMAL
Acenaphthylene	49	219.06	95.37	241.47	0.44	
Acenaphthene	70	334.81	287.22	391.29	0.86	
4-Nitrophenol	42	558.24	330.11	642.03	0.59	
Dibenzofuran	71	865.37	4479.03	1739.79	5.18	NOT NORMAL
2,4-Dinitrotoluene	70	344.71	279.30	399.63	0.81	
Fluorene	70	344.81	291.04	402.04	0.84	
N-Nitrosodiphenylamine (1)	37	193.65	22.29	199.68	0.12	
Phenanthrene	70	360.56	347.79	428.94	0.96	
Anthracene	70	333.76	289.72	390.72	0.87	
Di-n-butylphthalate	70	327.86	291.49	385.17	0.89	
Fluoranthene	70	372.90	374.10	446.45	1.00	NOT NORMAL
Pyrene	70	340.10	363.89	411.67	1.07	NOT NORMAL
Butylbenzylphthalate	1	140.00	ERR	ERR	ERR	ERR
Benzo(a)anthracene	70	348.26	302.60	407.73	0.87	
Chrysene	70	329.55	302.27	388.96	0.92	
bis(2-Ethylhexyl)phthalate	70	398.69	322.07	462.01	0.81	
Di-n-octylphthalate	39	175.00	55.01	189.49	0.31	
Benzo(b)fluoranthene	70	349.83	299.91	408.80	0.86	
benzo(k)fluoranthene	70	331.86	295.07	389.87	0.89	
Benzo(a)pyrene	70	337.80	295.82	395.96	0.88	
Indeno(1,2,3-cd)pyrene	70	329.64	288.65	386.30	0.88	
Dibenz(a,h)anthracene	70	332.01	285.61	388.17	0.86	
Benzo(g,h,i)perylene	70	318.13	291.34	375.41	0.92	
PESTICIDES/PCBs						
Heptachlor	77	5.73	4.02	6.48	0.70	
Dieldrin	77	11.45	8.10	12.97	0.71	
4,4'-DDE	77	22.58	39.76	30.04	1.76	NOT NORMAL
4,4'-DDD	77	14.44	11.71	16.64	0.81	
4,4'-DDT	77	16.51	22.33	20.69	1.35	NOT NORMAL
Aroclor-1242	70	59.90	37.71	67.32	0.63	
Aroclor-1260	77	172.29	148.03	200.04	0.86	
HERBICIDES						
2,4-DB	61	38.93	56.00	50.72	1.44	NOT NORMAL
2,4,5-TP (Silvex)	61	2.89	0.18	2.93	0.06	
MCPP	61	2906.20	167.13	2943.40	0.06	
METALS						
Aluminum	61	14913.61	3284.96	15605.49	0.22	
Antimony	61	3.83	1.68	4.19	0.44	
Arsenic	61	5.28	5.53	6.44	1.05	NOT NORMAL
Barium	61	79.38	31.55	86.02	0.40	
Beryllium	40	0.68	0.15	0.72	0.22	
Cadmium	61	1.70	1.60	2.04	0.94	
Calcium	61	32106.03	35534.07	39592.24	1.11	NOT NORMAL
Chromium	61	23.83	4.40	24.75	0.18	
Cobalt	61	12.35	2.73	12.93	0.22	
Copper	61	29.04	18.98	33.04	0.65	
Iron	61	29121.31	6483.91	30486.96	0.22	
Lead	59	43.06	95.53	63.54	2.22	NOT NORMAL
Magnesium	61	7406.20	2972.29	8034.22	0.40	
Manganese	61	656.69	286.17	716.96	0.44	
Mercury	57	0.06	0.11	0.09	1.78	NOT NORMAL
Nickel	61	36.16	7.83	37.81	0.22	
Potassium	61	1556.41	447.02	1650.56	0.29	
Selenium	61	0.30	0.35	0.37	1.17	NOT NORMAL
Silver	61	0.47	0.24	0.52	0.51	
Sodium	60	118.28	97.50	138.99	0.82	
Vanadium	57	21.71	4.41	22.67	0.20	
Zinc	61	300.23	689.36	445.42	2.30	NOT NORMAL
Cyanide	61	0.34	0.14	0.37	0.41	

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Compound	Concentration in Soil (ug/kg)	Theoretical Oil Concentration for 0.1 g/cm3 (ug/g)	Peak Emission Rate 1st 15 Min. (g/s−m2)	Short Term Emission Rate 1st Day (g/s−m2)
Vinyl chloride	799.8	11.92	1.41E−05	2.83E−06
Acetone	378.7	5.64	2.28E−06	4.68E−07
Carbon disulfide	159.7	2.38	1.03E−06	2.12E−07
1,1−Dichloroethene	161.63	2.41	1.17E−06	2.40E−07
1,2−Dichloroethene (total)	7668	114.25	3.08E−05	6.33E−06
Chloroform	11.58	0.17	5.56E−08	1.14E−08
1,2−Dichloroethane	149.2	2.22	4.48E−07	9.25E−08
2−Butanone	15.76	0.23	4.58E−08	9.45E−09
Trichloroethene	42351	631.03	1.07E−04	2.22E−05
Benzene	3.72	0.06	1.22E−08	2.51E−09
Tetrachloroethene	4.06	0.06	4.85E−09	1.01E−09
Toluene	430.5	6.41	7.20E−07	1.50E−07
Chlorobenzene	401.3	5.98	3.82E−07	8.02E−08
Ethylbenzene	242.6	3.61	2.14E−07	4.52E−08
Xylene	1288	19.19	1.02E−06	2.16E−07

14/45

```
SPECIFIED PARAMETERS FOR LAND TREATMENT
seneca

wind (cm/s)                                         447
Temp (C)                                            25
Oil content of waste (fraction)                     .1
concentration of compound (ppm)                     0
Time between applications (days)                    365.25
Waste loading (g oil/cc soil)                       .1
Thickness of contaminated soil (cm)                 30
Area of land treatment (m2)                         100
Aqueous waste, =1                                   0
Biomass density                                     .000001
Total porosity                                      .45
Air porosity                                        .4
width of land treatment area (meters)               158
length of land treatment area (meters)              158
amount of waste applied (gallons)                   0
fraction liquid in waste                            0
ETHYLBENZENE                              3.61 ppmw
METHYL ETHYL KETONE                       .23 ppmw
TETRACHLOROETHENE                         .06 ppmw
TOLUENE                                   6.41 ppmw
TRICHLOROETHYLENE                         631.03 ppmw
VINYL CHLORIDE                            11.92 ppmw
XYLENE                                    19.19 ppmw

STATUS CHECK

Waste loading (g oil/cc soil) is relatively large.
Time between applications (days) is relatively large.
```

CALCULATED VALUES FROM SPECIFICATIONS

SOURCE: land treatment

The area for waste application is 100 m2 (0 acres).

The waste application volume is 28 m3 (7500 gallons).

The tilling depth is 30.0 cm.(11.8 inches).

compound partitions into the oil that is present.

Biomass is present for biodegradation.

The wind speed is 4.5 m/s (10.0 M.P.H.)

The temperature is 25.0 deg. C (77.0 deg. F)

```
                 SOURCE: land treatment
                 COMPOUND: ETHYLBENZENE

Equilibrium  Keq                                     6.066909E-04
biological time const days-1                         147155.8
maximum fraction biodegraded                         3.383219E-03
fraction biodegraded during time period              1.318276E-03
fraction emitted during time period                  .6746765
residual comcentration in oil (ppmw)                 1.169659
diffusion coef cm2/s                                 1.751847E-02
emission rate during time period (g/s)               2.315368E-07
                 (Mg/year)                           7.301746E-06
emission factor  (g/cm2-s)                           2.315368E-13

Short term emissions, first day  (g/s)               4.517896E-06
Peak emissions, fifteen minutes  (g/s)               2.144611E-05



The reference emission factor is 5.882279E-14  g/cm2-sec.

COMPOUND PROPERTIES OF ETHYLBENZENE

Type of compound        A  aromatic
density (g/cc)                                              .87
molecular weight                                            106.2
diffusion coef. air   (cm2/s)                               .075
vapor pressure  (mm Hg)                                     10
Henry's law constant (atm m3/mol)                           .00644
vapor pressure temp. coefficients                           6.975
                                                             1424.255
                                                             213.21
biorate constant Kmax (mg/g-1-hr)                            6.8
UNIFAC code                                                31=115:0000000

STATUS CHECK

The estimated vapor pressure is 9.88  mm Hg.
```

```
                   SOURCE: land treatment
                   COMPOUND: METHYL ETHYL KETONE

Equilibrium  Keq                                     6.06691E-03
biological time const days-1                         500329.9
maximum fraction biodegraded                         1.259744E-03
fraction biodegraded during time period              6.094296E-05
fraction emitted during time period                  .9982697
residual comcentration in oil (ppmw)                 3.839574E-04
diffusion coef cm2/s                                 1.887323E-02
emission rate during time period (g/s)               2.182695E-08
                  (Mg/year)                          6.883346E-07
emission factor  (g/cm2-s)                           2.182695E-14

Short term emissions, first day  (g/s)               9.447842E-07
Peak emissions, fifteen minutes  (g/s)               4.582643E-06



The reference emission factor is 5.179344E-15  g/cm2-sec.

COMPOUND PROPERTIES OF METHYL ETHYL KETONE

Type of compound       O  oxygenate
density (g/cc)                                             .82
molecular weight                                           72.1
diffusion coef. air   (cm2/s)                              .0808
vapor pressure  (mm Hg)                                    100
Henry's law constant (atm m3/mol)                          .0000435
vapor pressure temp. coefficients                          6.97421
                                                            1209.6
                                                            216
biorate constant Kmax (mg/g-1-hr)                          2
UNIFAC code                                               311121C0000000

STATUS CHECK

biorate constant Kmax (mg/g-1-hr) is relatively low.
The estimated vapor diffusion coefficient is .1347373  cm2/s
The estimated vapor pressure is 90.17252  mm Hg.
```

```
                    SOURCE: land treatment
                    COMPOUND: TETRACHLOROETHENE

Equilibrium  Keq                                   1.152713E-03
biological time const days-1                       92998.12
maximum fraction biodegraded                       3.094673E-03
fraction biodegraded during time period            .0015475
fraction emitted during time period                .8459325
residual comcentration in oil (ppmw)               9.151201E-03
diffusion coef cm2/s                               1.681773E-02
emission rate during time period (g/s)             4.825077E-09
                (Mg/year)                          1.521636E-07
emission factor  (g/cm2-s)                         4.825077E-15

Short term emissions, first day  (g/s)             1.014126E-07
Peak emissions, fifteen minutes  (g/s)             4.854595E-07



The reference emission factor is 1.012803E-15  g/cm2-sec.

COMPOUND PROPERTIES OF TETRACHLOROETHENE

Type of compound       C  chlorinated
density (g/cc)                                          1.624
molecular weight                                        165.83
diffusion coef. air   (cm2/s)                           .072
vapor pressure  (mm Hg)                                 19
Henry's law constant (atm m3/mol)                       .029
vapor pressure temp. coefficients                       6.976
                                                         1386.92
                                                         217.53
biorate constant Kmax (mg/g-1-hr)                       10.76
UNIFAC code                                            2194v000000000

STATUS CHECK

density (g/cc) is relatively high.
The estimated vapor diffusion coefficient is .0318  cm2/s
The estimated vapor pressure is 18.088  mm Hg.

 k1 UNF bio df C
```

```
                SOURCE: land treatment
                COMPOUND: TOLUENE

Equilibrium  Keq                                    1.820073E-03
biological time const days-1                        13618.12
maximum fraction biodegraded                        7.941008E-03
fraction biodegraded during time period             6.513208E-03
fraction emitted during time period                 .9597321
residual comcentration in oil (ppmw)                .2163679
diffusion coef cm2/s                                2.032142E-02
emission rate during time period (g/s)              5.848241E-07
                 (Mg/year)                          1.844301E-05
emission factor  (g/cm2-s)                          5.848241E-13

Short term emissions, first day  (g/s)              1.496466E-05
Peak emissions, fifteen minutes  (g/s)              7.20146E-05




The reference emission factor is 7.185387E-14  g/cm2-sec.

COMPOUND PROPERTIES OF TOLUENE

Type of compound       A  aromatic
density (g/cc)                                             .87
molecular weight                                           92.4
diffusion coef. air   (cm2/s)                              .087
vapor pressure  (mm Hg)                                    30
Henry's law constant (atm m3/mol)                          .00668
vapor pressure temp. coefficients                          6.954
                                                            1344.8
                                                            219.48
biorate constant Kmax (mg/g-1-hr)                          73.48
UNIFAC code                                               25:1<000000000

STATUS CHECK

biorate constant Kmax (mg/g-1-hr) is relatively high.
The estimated vapor pressure is 28.348  mm Hg.
```

```
                SOURCE: land treatment
                COMPOUND: TRICHLOROETHYLENE

Equilibrium  Keq                                   4.550182E-03
biological time const days-1                       256579.4
maximum fraction biodegraded                       1.358926E-03
fraction biodegraded during time period            1.610189E-04
fraction emitted during time period                .9976444
residual comcentration in oil (ppmw)               1.384831
diffusion coef cm2/s                               1.845279E-02
emission rate during time period (g/s)             5.98471E-05
                (Mg/year)                          1.887338E-03
emission factor  (g/cm2-s)                         5.98471E-11

Short term emissions, first day  (g/s)             2.219694E-03
Peak emissions, fifteen minutes  (g/s)             1.074961E-02



The reference emission factor is 1.393892E-11  g/cm2-sec.

COMPOUND PROPERTIES OF TRICHLOROETHYLENE

Type of compound       C  chlorinated
density (g/cc)                                           1.4
molecular weight                                         131.4
diffusion coef. air   (cm2/s)                            .079
vapor pressure  (mm Hg)                                  75
Henry's law constant (atm m3/mol)                        .0091
vapor pressure temp. coefficients                        6.518
                                                          1018.6
                                                          192.7
biorate constant Kmax (mg/g-1-hr)                        3.9
UNIFAC code                                             21^1b000000000

STATUS CHECK

density (g/cc) is relatively high.
biorate constant Kmax (mg/g-1-hr) is relatively low.
The estimated vapor diffusion coefficient is .0465  cm2/s
The estimated vapor pressure is 69.008  mm Hg.
```

```
                 SOURCE: land treatment
                 COMPOUND: VINYL CHLORIDE

Equilibrium  Keq                                  .1613798
biological time const days-1                      92998.12
maximum fraction biodegraded                      1.209199E-03
fraction biodegraded during time period           1.562876E-05
fraction emitted during time period               .9983606
residual comcentration in oil (ppmw)              1.935566E-02
diffusion coef cm2/s                              2.475943E-02
emission rate during time period (g/s)            1.131308E-06
                 (Mg/year)                        3.567694E-05
emission factor  (g/cm2-s)                        1.131308E-12

Short term emissions, first day  (g/s)            2.830065E-04
Peak emissions, fifteen minutes  (g/s)            1.414397E-03



The reference emission factor is 2.711327E-13  g/cm2-sec.

COMPOUND PROPERTIES OF VINYL CHLORIDE

Type of compound        C  chlorinated
density (g/cc)                                         .91
molecular weight                                       62.5
diffusion coef. air   (cm2/s)                          .106
vapor pressure   (mm Hg)                               2660
Henry's law constant (atm m3/mol)                      .086
vapor pressure temp. coefficients                      3.42486
                                                        1000
                                                        273.16
biorate constant Kmax (mg/g-1-hr)                      10.76
UNIFAC code

STATUS CHECK

The estimated vapor diffusion coefficient is .1583757  cm2/s
The estimated vapor pressure is 1.1704  mm Hg.

 k1 low bio df C a df  a df
```

```
              SOURCE: land treatment
              COMPOUND: XYLENE

Equilibrium  Keq                                 5.156873E-04
biological time const days-1                     24525.97
maximum fraction biodegraded                     1.711321E-02
fraction biodegraded during time period          8.483052E-03
fraction emitted during time period              .6104454
residual comcentration in oil (ppmw)             7.312764
diffusion coef cm2/s                             1.667758E-02
emission rate during time period (g/s)           1.113625E-06
               (Mg/year)                         3.511929E-05
emission factor  (g/cm2-s)                       1.113625E-12

Short term emissions, first day  (g/s)           2.160365E-05
Peak emissions, fifteen minutes  (g/s)           1.022544E-04



The reference emission factor is 1.392067E-13  g/cm2-sec.

COMPOUND PROPERTIES OF XYLENE

Type of compound       A  aromatic
density (g/cc)                                        1.02
molecular weight                                      106.2
diffusion coef. air   (cm2/s)                         .0714
vapor pressure  (mm Hg)                               8.5
Henry's law constant (atm m3/mol)                     .00525
vapor pressure temp. coefficients                     .929413
                                                       1000
                                                       273.16
biorate constant Kmax (mg/g-1-hr)                     40.8
UNIFAC code                                          24:2<000000000

STATUS CHECK

The estimated vapor pressure is .003762  mm Hg.

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SUMMARY OF LONG TERM EMISSION FACTORS
seneca

compounds	conc. (ppmw)	emissions (g/s)
ETHYLBENZENE	3.61	2.315368E-07
METHYL ETHYL KETONE	0.23	2.182695E-08
TETRACHLOROETHENE	.600E-01	4.825077E-09
TOLUENE	6.41	5.848241E-07
TRICHLOROETHYLENE	631.03	5.98471E-05
VINYL CHLORIDE	11.92	1.131308E-06
XYLENE	19.19	1.113625E-06

SPECIFIED PARAMETERS FOR LAND TREATMENT
seneca

wind (cm/s)	447
Temp (C)	25
Oil content of waste (fraction)	.1
concentration of compound (ppm)	0
Time between applications (days)	365.25
Waste loading (g oil/cc soil)	.1
Thickness of contaminated soil (cm)	30
Area of land treatment (m2)	100
Aqueous waste, =1	0
Biomass density	.000001
Total porosity	.45
Air porosity	.4
width of land treatment area (meters)	158
length of land treatment area (meters)	158
amount of waste applied (gallons)	0
fraction liquid in waste	0
ACETONE	5.64 ppmw
BENZENE	.06 ppmw
CARBON DISULFIDE	2.38 ppmw
CHLOROBENZENE	5.98 ppmw
CHLOROFORM	.17 ppmw
DICHLOROETHANE(1,2)	2.22 ppmw
DICHLOROETHYLENE(1,1)	2.41 ppmw
DICHLOROETHYLENE(1,2)	114.25 ppmw

STATUS CHECK

Waste loading (g oil/cc soil) is relatively large.
Time between applications (days) is relatively large.

25/45

```
   CALCULATED VALUES FROM SPECIFICATIONS


                      SOURCE: land treatment



The area for waste application is     100 m2 (   0 acres).

The waste application volume is      28 m3 (   7500 gallons).

The tilling depth is  30.0 cm.( 11.8 inches).

compound partitions into the oil that is present.

Biomass is present for biodegradation.

The wind speed is   4.5 m/s ( 10.0 M.P.H.)

The temperature is  25.0 deg. C ( 77.0 deg. F)
```

```
                SOURCE: land treatment
                COMPOUND: ACETONE

Equilibrium  Keq                                 1.613798E-02
biological time const days-1                     769738.3
maximum fraction biodegraded                     1.209497E-03
fraction biodegraded during time period          1.031009E-05
fraction emitted during time period              .9983603
residual comcentration in oil (ppmw)             9.189893E-03
diffusion coef cm2/s                             2.896386E-02
emission rate during time period (g/s)           5.352833E-07
                 (Mg/year)                       1.688069E-05
emission factor  (g/cm2-s)                       5.352833E-13

Short term emissions, first day  (g/s)           4.680906E-05
Peak emissions, fifteen minutes  (g/s)           2.280165E-04




The reference emission factor is 1.282799E-13  g/cm2-sec.

COMPOUND PROPERTIES OF ACETONE

Type of compound       O  oxygenate
density (g/cc)                                         .79
molecular weight                                       58
diffusion coef. air   (cm2/s)                          .124
vapor pressure  (mm Hg)                                266
Henry's law constant (atm m3/mol)                      .000025
vapor pressure temp. coefficients                      7.117
                                                        1210.595
                                                        229.664
biorate constant Kmax (mg/g-l-hr)                       1.3
UNIFAC code                                            2211C000000000

STATUS CHECK

biorate constant Kmax (mg/g-l-hr) is relatively low.
The estimated vapor diffusion coefficient is .1871243  cm2/s
The estimated vapor pressure is 230.8057  mm Hg.
```

```
                    SOURCE: land treatment
                    COMPOUND: BENZENE

Equilibrium  Keq                                      5.775698E-03
biological time const days-1                          52666.3
maximum fraction biodegraded                          1.747251E-03
fraction biodegraded during time period               5.581543E-04
fraction emitted during time period                   .997795
residual comcentration in oil (ppmw)                  9.880801E-05
diffusion coef cm2/s                                  .020555
emission rate during time period (g/s)                5.691279E-09
                (Mg/year)                             1.794802E-07
emission factor  (g/cm2-s)                            5.691279E-15

Short term emissions, first day  (g/s)                2.509619E-07
Peak emissions, fifteen minutes  (g/s)                1.217166E-06



The reference emission factor is 1.235017E-15  g/cm2-sec.

COMPOUND PROPERTIES OF BENZENE

Type of compound      A  aromatic
density (g/cc)                                              .87
molecular weight                                            78.1
diffusion coef. air   (cm2/s)                               .088
vapor pressure  (mm Hg)                                     95.2
Henry's law constant (atm m3/mol)                           .0055
vapor pressure temp. coefficients                           6.905
                                                             1211.033
                                                             220.79
biorate constant Kmax (mg/g-1-hr)                           19
UNIFAC code                                                16:00000000000

STATUS CHECK

The estimated vapor diffusion coefficient is .1173281  cm2/s
The estimated vapor pressure is 95.02693  mm Hg.
```

```
                    SOURCE: land treatment
                    COMPOUND: CARBON DISULFIDE

Equilibrium  Keq                                       2.220489E-02
biological time const days-1                           65402.59
maximum fraction biodegraded                           1.297057E-03
fraction biodegraded during time period                1.060554E-04
fraction emitted during time period                    .9982728
residual comcentration in oil (ppmw)                   3.858238E-03
diffusion coef cm2/s                                   2.429227E-02
emission rate during time period (g/s)                 2.258622E-07
              (Mg/year)                                7.12279E-06
emission factor  (g/cm2-s)                             2.258622E-13

Short term emissions, first day  (g/s)                 2.121932E-05
Peak emissions, fifteen minutes  (g/s)                 1.034354E-04



The reference emission factor is 5.320464E-14  g/cm2-sec.

COMPOUND PROPERTIES OF CARBON DISULFIDE

Type of compound       S  sulfur
density (g/cc)                                              1.26
molecular weight                                            76.1
diffusion coef. air   (cm2/s)                               .104
vapor pressure  (mm Hg)                                     366
Henry's law constant (atm m3/mol)                           .0168
vapor pressure temp. coefficients                           6.942
                                                             1169.11
                                                             241.59
biorate constant Kmax (mg/g-1-hr)                           15.3
UNIFAC code

STATUS CHECK

The estimated vapor pressure is 360.1746  mm Hg.

 k1 UNF bio df C k1 low bio df S
```

```
                    SOURCE: land treatment
                    COMPOUND: CHLOROBENZENE

Equilibrium  Keq                                      7.158953E-04
biological time const days-1                          2565794
maximum fraction biodegraded                          1.309335E-03
fraction biodegraded during time period               7.146597E-05
fraction emitted during time period                   .7164169
residual comcentration in oil  (ppmw)                 1.6954
diffusion coef cm2/s                                  1.705131E-02
emission rate during time period (g/s)                4.072717E-07
                 (Mg/year)                            1.284372E-05
emission factor  (g/cm2-s)                            4.072717E-13

Short term emissions, first day  (g/s)                8.020528E-06
Peak emissions, fifteen minutes  (g/s)                3.816182E-05



The reference emission factor is 1.333553E-13  g/cm2-sec.

COMPOUND PROPERTIES OF CHLOROBENZENE

Type of compound        C  chlorinated
density (g/cc)                                               1.11
molecular weight                                             112.6
diffusion coef. air   (cm2/s)                                .073
vapor pressure  (mm Hg)                                      11.8
Henry's law constant (atm m3/mol)                            .00393
vapor pressure temp. coefficients                            6.978
                                                              1431.05
                                                              217.55
biorate constant Kmax (mg/g-l-hr)                            .39
UNIFAC code                                                 25:1^000000000

STATUS CHECK

biorate constant Kmax (mg/g-l-hr) is relatively low.
The estimated vapor diffusion coefficient is .0635  cm2/s
The estimated vapor pressure is 11.932  mm Hg.
```

```
                    SOURCE: land treatment
                    COMPOUND: CHLOROFORM

Equilibrium  Keq                                   1.261917E-02
biological time const days-1                       340360.4
maximum fraction biodegraded                       1.232803E-03
fraction biodegraded during time period            3.4531E-05
fraction emitted during time period                .998337
residual comcentration in oil (ppmw)               2.768346E-04
diffusion coef cm2/s                               2.429227E-02
emission rate during time period (g/s)             1.613405E-08
                 (Mg/year)                         5.088034E-07
emission factor  (g/cm2-s)                         1.613405E-14

Short term emissions, first day  (g/s)             1.142605E-06
Peak emissions, fifteen minutes  (g/s)             5.560659E-06



The reference emission factor is 3.848678E-15  g/cm2-sec.

COMPOUND PROPERTIES OF CHLOROFORM

Type of compound       C  chlorinated
density (g/cc)                                          1.49
molecular weight                                        119.4
diffusion coef. air   (cm2/s)                           .104
vapor pressure  (mm Hg)                                 208
Henry's law constant (atm m3/mol)                       .00339
vapor pressure temp. coefficients                       6.493
                                                         929.44
                                                         196.03
biorate constant Kmax (mg/g-l-hr)                        2.94
UNIFAC code                                             11c00000000000

STATUS CHECK

density (g/cc) is relatively high.
biorate constant Kmax (mg/g-l-hr) is relatively low.
The estimated vapor diffusion coefficient is .0517  cm2/s
The estimated vapor pressure is 194.0453  mm Hg.
```

```
                  SOURCE: land treatment
                  COMPOUND: DICHLOROETHANE(1,2)

Equilibrium  Keq                                   4.853528E-03
biological time const days-1                       476504.7
maximum fraction biodegraded                       1.260936E-03
fraction biodegraded during time period            6.218813E-05
fraction emitted during time period                .9982788
residual comcentration in oil (ppmw)               3.683014E-03
diffusion coef cm2/s                               2.429227E-02
emission rate during time period (g/s)             2.106794E-07
                 (Mg/year)                         6.643986E-06
emission factor  (g/cm2-s)                         2.106794E-13

Short term emissions, first day   (g/s)            9.253664E-06
Peak emissions, fifteen minutes   (g/s)            4.4853E-05



The reference emission factor is 4.998032E-14  g/cm2-sec.

COMPOUND PROPERTIES OF DICHLOROETHANE(1,2)

Type of compound       C  chlorinated
density (g/cc)                                          1.26
molecular weight                                        99
diffusion coef. air   (cm2/s)                           .104
vapor pressure  (mm Hg)                                 80
Henry's law constant (atm m3/mol)                       .0012
vapor pressure temp. coefficients                       7.025
                                                         1272.3
                                                         222.9
biorate constant Kmax (mg/g-1-hr)                       2.1
UNIFAC code                                            12]00000000000

STATUS CHECK

biorate constant Kmax (mg/g-1-hr) is relatively low.
The estimated vapor diffusion coefficient is .0719  cm2/s
The estimated vapor pressure is 78.09826  mm Hg.

 k1 low bio df C a df  a df
```

```
                    SOURCE: land treatment
                    COMPOUND: DICHLOROETHYLENE(1,1)

Equilibrium  Keq                                      3.822153E-02
biological time const days-1                          92998.12
maximum fraction biodegraded                          1.254857E-03
fraction biodegraded during time period               6.122631E-05
fraction emitted during time period                   .998315
residual comcentration in oil (ppmw)                  3.913351E-03
diffusion coef cm2/s                                  1.756518E-02
emission rate during time period (g/s)                2.287188E-07
               (Mg/year)                              7.212877E-06
emission factor  (g/cm2-s)                            2.287188E-13

Short term emissions, first day  (g/s)                2.397144E-05
Peak emissions, fifteen minutes  (g/s)                1.169641E-04



The reference emission factor is 5.432327E-14  g/cm2-sec.

COMPOUND PROPERTIES OF DICHLOROETHYLENE(1,1)

Type of compound       C  chlorinated
density (g/cc)                                              1.21
molecular weight                                            97
diffusion coef. air   (cm2/s)                               .0752
vapor pressure  (mm Hg)                                     630
Henry's law constant (atm m3/mol)                           .015
vapor pressure temp. coefficients                           6.9722
                                                             1099.4
                                                             237.2
biorate constant Kmax (mg/g-1-hr)                           10.76
UNIFAC code                                                2162v000000000

STATUS CHECK

The estimated vapor pressure is 601.379  mm Hg.

 den df A dl cor dv cor a df  a df  bio df C dl cor dv cor
```

```
                  SOURCE: land treatment
                  COMPOUND: DICHLOROETHYLENE(1,2)

Equilibrium  Keq                                    1.213382E-02
biological time const days-1                        92998.12
maximum fraction biodegraded                        1.37645E-03
fraction biodegraded during time period             1.827602E-04
fraction emitted during time period                 .9981934
residual comcentration in oil (ppmw)                .1855188
diffusion coef cm2/s                                1.719145E-02
emission rate during time period (g/s)              1.084147E-05
                 (Mg/year)                          3.418966E-04
emission factor  (g/cm2-s)                          1.084147E-11

Short term emissions, first day  (g/s)              6.334437E-04
Peak emissions, fifteen minutes  (g/s)              3.081097E-03



The reference emission factor is 2.515229E-12  g/cm2-sec.

COMPOUND PROPERTIES OF DICHLOROETHYLENE(1,2)

Type of compound       C  chlorinated
density (g/cc)                                           1.28
molecular weight                                         96.95
diffusion coef. air   (cm2/s)                            .0736
vapor pressure  (mm Hg)                                  200
Henry's law constant (atm m3/mol)                        .0319
vapor pressure temp. coefficients                        7.0223
                                                          1205.4
                                                          230.6
biorate constant Kmax (mg/g-1-hr)                        10.76
UNIFAC code

STATUS CHECK

The estimated vapor pressure is 202.4324  mm Hg.

 k1 df C bio df C dl cor dv cor
```

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SUMMARY OF LONG TERM EMISSION FACTORS
seneca

compounds	conc. (ppmw)	emissions (g/s)
ACETONE	5.64	5.352833E-07
BENZENE	.600E-01	5.691279E-09
CARBON DISULFIDE	2.38	2.258622E-07
CHLOROBENZENE	5.98	4.072717E-07
CHLOROFORM	0.17	1.613405E-08
DICHLOROETHANE(1,2)	2.22	2.106794E-07
DICHLOROETHYLENE(1,1)	2.41	2.287188E-07
DICHLOROETHYLENE(1,2)	114.25	1.084147E-05

```
SPECIFIED PARAMETERS FOR LAND TREATMENT
seneca

wind (cm/s)                                                  447
Temp (C)                                                     25
Oil content of waste (fraction)                              .1
concentration of compound (ppm)                              0
Time between applications (days)                             365.25
Waste loading (g oil/cc soil)                                .1
Thickness of contaminated soil (cm)                          30
Area of land treatment (m2)                                  100
Aqueous waste, =1                                            0
Biomass density                                              .000001
Total porosity                                               .45
Air porosity                                                 .4
width of land treatment area (meters)                        158
length of land treatment area (meters)                       158
amount of waste applied (gallons)                            0
fraction liquid in waste                                     0
BENZOPYRENE 3,4                                      5.9 ppmw
NAPHTHALENE                                          7.59 ppmw
NITROPHENOL,4-                                       9.57 ppmw
PHENOL                                               12.5 ppmw

STATUS CHECK

Waste loading (g oil/cc soil) is relatively large.
Time between applications (days) is relatively large.
```

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CALCULATED VALUES FROM SPECIFICATIONS

SOURCE: land treatment

The area for waste application is 100 m2 (0 acres).

The waste application volume is 28 m3 (7500 gallons).

The tilling depth is 30.0 cm.(11.8 inches).

compound partitions into the oil that is present.

Biomass is present for biodegradation.

The wind speed is 4.5 m/s (10.0 M.P.H.)

The temperature is 25.0 deg. C (77.0 deg. F)

```
                SOURCE: land treatment
                COMPOUND: BENZOPYRENE 3,4

Equilibrium  Keq                                   4.604957E-08
biological time const days-1                       32175.55
maximum fraction biodegraded                       .972598
fraction biodegraded during time period            1.423491E-02
fraction emitted during time period                3.098731E-04
residual comcentration in oil (ppmw)               5.814186
diffusion coef cm2/s                               5.278898E-03
emission rate during time period (g/s)             1.738014E-10
                 (Mg/year)                         5.481001E-09
emission factor  (g/cm2-s)                         1.738014E-16

Short term emissions, first day  (g/s)             1.747888E-10
Peak emissions, fifteen minutes  (g/s)             3.140446E-08



The reference emission factor is 1.179705E-08  g/cm2-sec.

COMPOUND PROPERTIES OF BENZOPYRENE 3,4

Type of compound       A  aromatic
density (g/cc)                                          1.02
molecular weight                                        252.32
diffusion coef. air   (cm2/s)                           .0226
vapor pressure  (mm Hg)                                 7.590285E-04
Henry's law constant (atm m3/mol)                       .000126
vapor pressure temp. coefficients                      -3.119722
                                                         1000
                                                         273.16
biorate constant Kmax (mg/g-1-hr)                       31.1
UNIFAC code

STATUS CHECK

molecular weight is relatively high.
diffusion coef. air   (cm2/s) is relatively low.
The estimated vapor pressure is 3.3592E-07  mm Hg.

 den df A vp hls k1 df A bio df A dl cor dv cor a df  a df  a df
```

```
                    SOURCE: land treatment
                    COMPOUND: NAPHTHALENE

Equilibrium  Keq                                    1.395389E-05
biological time const days-1                        23561.57
maximum fraction biodegraded                        .392375
fraction biodegraded during time period             1.443594E-02
fraction emitted during time period                 9.217793E-02
residual comcentration in oil (ppmw)                6.780801
diffusion coef cm2/s                                1.378119E-02
emission rate during time period (g/s)              6.650986E-08
                (Mg/year)                           2.097455E-06
emission factor  (g/cm2-s)                          6.650986E-14

Short term emissions, first day  (g/s)              1.277689E-06
Peak emissions, fifteen minutes  (g/s)              5.130601E-06



The reference emission factor is 2.633833E-11  g/cm2-sec.

COMPOUND PROPERTIES OF NAPHTHALENE

Type of compound       A  aromatic
density (g/cc)                                            1.14
molecular weight                                          128.2
diffusion coef. air   (cm2/s)                             .059
vapor pressure  (mm Hg)                                   .23
Henry's law constant (atm m3/mol)                         .00048
vapor pressure temp. coefficients                         7.01
                                                           1733.71
                                                           201.86
biorate constant Kmax (mg/g-1-hr)                         42.47
UNIFAC code                                              28:2;000000000

STATUS CHECK

diffusion coef. air   (cm2/s) is relatively low.
The estimated vapor diffusion coefficient is .0526  cm2/s
The estimated vapor pressure is .23256  mm Hg.
```

```
                SOURCE: land treatment
                COMPOUND: NITROPHENOL,4-

Equilibrium  Keq                                      1.33472E-04
biological time const days-1                          103160.8
maximum fraction biodegraded                          2.522385E-02
fraction biodegraded during time period               2.958387E-03
fraction emitted during time period                   .2443542
residual comcentration in oil (ppmw)                  7.203219
diffusion coef cm2/s                                  1.004392E-02
emission rate during time period (g/s)                2.223049E-07
                (Mg/year)                             7.010606E-06
emission factor  (g/cm2-s)                            2.223049E-13

Short term emissions, first day  (g/s)                4.253589E-06
Peak emissions, fifteen minutes  (g/s)                1.938318E-05



The reference emission factor is 1.258414E-12  g/cm2-sec.

COMPOUND PROPERTIES OF NITROPHENOL,4-

Type of compound       N  nitrogen
density (g/cc)                                              1.4
molecular weight                                            139.11
diffusion coef. air   (cm2/s)                               .043
vapor pressure  (mm Hg)                                     2.2
Henry's law constant (atm m3/mol)                           .00634
vapor pressure temp. coefficients                           10.88068
                                                             4417.218
                                                             273.16
biorate constant Kmax (mg/g-1-hr)                            9.7
UNIFAC code                                                34:1B1j0000000

STATUS CHECK

density (g/cc) is relatively high.
diffusion coef. air   (cm2/s) is relatively low.
The estimated vapor pressure is 1.1628E-04  mm Hg.

 k1 low bio df N dl cor dv cor a vpbp
```

```
                SOURCE: land treatment
                COMPOUND: PHENOL

Equilibrium  Keq                                     2.068816E-05
biological time const days-1                         10316.08
maximum fraction biodegraded                         .4132372
fraction biodegraded during time period              3.172934E-02
fraction emitted during time period                  .1314362
residual comcentration in oil (ppmw)                 10.46043
diffusion coef cm2/s                                 1.915352E-02
emission rate during time period (g/s)               1.561861E-07
                (Mg/year)                            4.925485E-06
emission factor  (g/cm2-s)                           1.561861E-13

Short term emissions, first day  (g/s)               3.020505E-06
Peak emissions, fifteen minutes  (g/s)               1.26384E-05



The reference emission factor is 4.805418E-11  g/cm2-sec.

COMPOUND PROPERTIES OF PHENOL

Type of compound       O  oxygenate
density (g/cc)                                             1.07
molecular weight                                           94.1
diffusion coef. air   (cm2/s)                              .082
vapor pressure  (mm Hg)                                    .341
Henry's law constant (atm m3/mol)                          4.54E-07
vapor pressure temp. coefficients                          7.133
                                                            1516.79
                                                            174.95
biorate constant Kmax (mg/g-1-hr)                          97
UNIFAC code                                               25:1B000000000

STATUS CHECK

biorate constant Kmax (mg/g-1-hr) is relatively high.
The estimated vapor pressure is .35188  mm Hg.
```

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SUMMARY OF LONG TERM EMISSION FACTORS

seneca

compounds	conc. (ppmw)	emissions (g/s)
BENZOPYRENE 3,4	5.90	1.738014E-10
NAPHTHALENE	7.59	6.650986E-08
NITROPHENOL,4-	9.57	2.223049E-07
PHENOL	12.50	1.561861E-07

```
                SOURCE: land treatment
                COMPOUND: DDD,p,p'-

Equilibrium  Keq                                      6.188248E-11
biological time const days-1                          65402.59
maximum fraction biodegraded                          .9988101
fraction biodegraded during time period               5.662252E-03
fraction emitted during time period                   6.626456E-06
residual comcentration in oil (ppmw)                  .2485828
diffusion coef cm2/s                                  3.643841E-03
emission rate during time period (g/s)                1.574848E-13
              (Mg/year)                               4.96644E-12
emission factor  (g/cm2-s)                            1.574848E-19

Short term emissions, first day  (g/s)                1.579237E-13
Peak emissions, fifteen minutes  (g/s)                1.691443E-12



The reference emission factor is 2.651003E-07  g/cm2-sec.

COMPOUND PROPERTIES OF DDD,p,p'-

Type of compound       P  pesticide
density (g/cc)                                             1.18
molecular weight                                           320.05
diffusion coef. air   (cm2/s)                              .0156
vapor pressure  (mm Hg)                                    1.02E-06
Henry's law constant (atm m3/mol)                          2.147726E-05
vapor pressure temp. coefficients                         -5.991361
                                                            1000
                                                            273.16
biorate constant Kmax (mg/g-1-hr)                          15.3
UNIFAC code

STATUS CHECK

molecular weight is relatively high.
diffusion coef. air   (cm2/s) is relatively low.
The estimated vapor pressure is 4.5144E-10  mm Hg.

 den df P Hl vps kl low bio df P dl cor dv cor a df  a df
```

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```
                    SOURCE: land treatment
                    COMPOUND: DDE,p,p'-

Equilibrium  Keq                                    3.943491E-10
biological time const days-1                        65402.59
maximum fraction biodegraded                        .9969802
fraction biodegraded during time period             5.805484E-03
fraction emitted during time period                 1.681754E-05
residual comcentration in oil (ppmw)                .4473799
diffusion coef cm2/s                                3.682919E-03
emission rate during time period (g/s)              7.194362E-13
                    (Mg/year)                       2.268814E-11
emission factor  (g/cm2-s)                          7.194362E-19

Short term emissions, first day  (g/s)              7.214415E-13
Peak emissions, fifteen minutes  (g/s)              1.931724E-11



The reference emission factor is 7.408612E-08  g/cm2-sec.

COMPOUND PROPERTIES OF DDE,p,p'-

Type of compound        P  pesticide
density (g/cc)                                          1.18
molecular weight                                        318.03
diffusion coef. air   (cm2/s)                           .0157673
vapor pressure  (mm Hg)                                 .0000065
Henry's law constant (atm m3/mol)                       6.800052E-05
vapor pressure temp. coefficients                      -5.187053
                                                         1000
                                                         273.16
biorate constant Kmax (mg/g-1-hr)                       15.3
UNIFAC code

STATUS CHECK

molecular weight is relatively high.
diffusion coef. air   (cm2/s) is relatively low.
The estimated vapor pressure is 2.8728E-09  mm Hg.

 den df P Hl vps kl low bio df P dl cor dv cor a df  a df
```

```
                SOURCE: land treatment
                COMPOUND: DDT

Equilibrium  Keq                                 9.100365E-12
biological time const days-1                     65402.59
maximum fraction biodegraded                     .9995724
fraction biodegraded during time period          5.602541E-03
fraction emitted during time period              2.381352E-06
residual comcentration in oil (ppmw)             .3082625
diffusion coef cm2/s                             3.20004E-03
emission rate during time period (g/s)           7.017824E-14
                 (Mg/year)                       2.213141E-12
emission factor  (g/cm2-s)                       7.017824E-20

Short term emissions, first day  (g/s)           7.037385E-14
Peak emissions, fifteen minutes  (g/s)           2.840798E-13



The reference emission factor is 2.545335E-06  g/cm2-sec.

COMPOUND PROPERTIES OF DDT

Type of compound       P  pesticide
density (g/cc)                                        1.18
molecular weight                                      354.49
diffusion coef. air   (cm2/s)                         .0137
vapor pressure  (mm Hg)                               1.5E-07
Henry's law constant (atm m3/mol)                     .114
vapor pressure temp. coefficients                     15.19374
                                                       6564.769
                                                       273.16
biorate constant Kmax (mg/g-l-hr)                     15.3
UNIFAC code                                          58:1>1d2f1;000

STATUS CHECK

molecular weight is relatively high.
diffusion coef. air   (cm2/s) is relatively low.
The estimated vapor pressure is 1.4972E-07  mm Hg.

 den df P k1 low bio df P dl cor dv cor a vpbp
```

```
                SOURCE: land treatment
                COMPOUND: DIELDRIN

Equilibrium  Keq                                      1.092044E-11
biological time const days-1                          65402.59
maximum fraction biodegraded                          .9995525
fraction biodegraded during time period               .0056041
fraction emitted during time period                   2.491775E-06
residual comcentration in oil (ppmw)                  .1889347
diffusion coef cm2/s                                  2.919744E-03
emission rate during time period (g/s)                4.500697E-14
                 (Mg/year)                            1.41934E-12
emission factor  (g/cm2-s)                            4.500697E-20

Short term emissions, first day  (g/s)                4.513242E-14
Peak emissions, fifteen minutes  (g/s)                1.964459E-13



The reference emission factor is 1.42484E-06  g/cm2-sec.

COMPOUND PROPERTIES OF DIELDRIN

Type of compound       P  pesticide
density (g/cc)                                              1.18
molecular weight                                            380.93
diffusion coef. air   (cm2/s)                               .0125
vapor pressure  (mm Hg)                                     1.8E-07
Henry's law constant (atm m3/mol)                           .0000584
vapor pressure temp. coefficients                          -6.744684
                                                             1000
                                                             273.16
biorate constant Kmax (mg/g-1-hr)                           15.3
UNIFAC code

STATUS CHECK

molecular weight is relatively high.
diffusion coef. air   (cm2/s) is relatively low.
The estimated vapor pressure is 7.904E-11  mm Hg.

 den df P k1 df P bio df P dl cor dv cor a df  a df
```

Calculation of Air Emissions for Low Temperature Thermal Desorption Treatment System

Client Seneca Army Depot
ibject Ash Landfill Removal Action
Thermal Desorption Air Emissions
Job No. 720489-01000
By DMK
Checked
Sheet 1 of 20
Date 10/14/93
Rev.

Estimate Air Emissions from Thermal Desorption Unit

Inputs

1) Mass throughputs
- Use 95th percentile U.C.L. concentration for average soil concentrations to calculate annual concentrations
- Use maximum concentrations for short term concentrations

2) Unit specifications

Weston -	Canonie -
8" diameter stack	2.2' diameter stack
15' tall stack	15' tall stack
70°F Temperature	100°F temperature
1400 acfm	17,208 acfm
20 tons per hour	20 tons per hour

Assumptions
1) No emissions controls
2) 2 months of operation
3) Nearest receptor is at SEDA boundary - 260 m from source

Calculations

calculate potential emissions (lb/hour) use vinyl chloride as example

$$P.E.(lb/hr) = C(\mu g/\cancel{kg}) \times 20\ \cancel{tons}/hour \times 2000\ \frac{lb}{\cancel{ton}} \times \frac{1\ \cancel{kg}}{2.2\ lb} \times \frac{1\ lb}{454\times10^{6}\ \mu g}$$

$$= (799.8)(0.00004\ )$$

$$\boxed{= 0.032}$$

Client: Seneca Army Depot
Job No. 720489-01000
Sheet 2 of 20

bject: Ash Landfill Removal Action
Thermal Desorption Air Emissions
By: DMK
Date: 10/14/93

Checked:
Rev.:

Convert to g/sec

$0.032\ \text{lb/hour} \times 454\ \text{g/lb} \times \frac{1\ \text{hour}}{3600\ \text{sec}} = \boxed{0.004\ \text{g/sec}}$

Next, run SCREEN model to estimate concentrations at receptor. Use a 1 g/sec source · estimate 1-hour impact

Max concentration = 749.8 µg/m3

Scale for actual source = 0.004 g/sec

$0.004\ \text{g/sec} \times 749.8 = 2.99\ \mu\text{g/m}^3$ at receptor

Next, estimate annual impact

$$\begin{aligned} \text{Annual} &= 0.1 \times 1\text{-hour} \\ &= 0.1 \times 2.99 \\ &= 0.3 \end{aligned}$$

Next, estimate based on 2 months unit will run

$\boxed{0.3/6 = 0.05\ \mu\text{g/m}^3}$

Thermal Desorption Air Emissions Estimate
Weston Unit – 20 Tons per Hour Throughput

Compound	95th % UCL Concentration in Soil (ug/kg)	Maximum Concentration in Soil (ug/kg)	Average Mass Throughput (grams per hour)	Average Potential Emissions (lb/hr)	Average Potential Emissions (g/sec)	Maximum Potential Emissions (lb/hr)	Maximum Potential Emissions (g/sec)	Adjusted Annual Concentration (ug/m3)	AGC (ug/m3)	Maximum Short-term Concentration (ug/m3)	SGC (ug/m3)
Volatiles											
Vinyl chloride	799.8	1000	15	0.0320	0.004035	0.04	0.005044	0.050	0.02	3.78	1300
Acetone	378.7	680	7	0.0151	0.00191	0.03	0.00343	0.024	14000	2.57	140,000
Carbon disulfide	159.7	120	3	0.0064	0.000808	0.00	0.000605	0.0101	7	0.45	710
1,1-Dichloroethene	161.63	140	3	0.0065	0.000815	0.01	0.000706	0.0102	0.02	0.53	2,000
1,2-Dichloroethene (total)	7668	79000	139	0.3067	0.038681	3.16	0.398511	0.483	1900	298.80	190,000
Chloroform	11.58	32	0	0.0005	0.000058	0.00	0.000161	0.0007	23	0.12	980
1,2-Dichloroethane	149.2	210	3	0.0060	0.000753	0.01	0.001059	0.0094	0.039	0.79	950
2-Butanone	15.76	22	0	0.0006	0.00008	0.00	0.000111	0.00099	300	0.08	140,000
Trichloroethene	42351	540000	770	1.6940	0.213637	21.60	2.724	2.670	0.45	2042.46	33,000
Benzene	3.72	6	0	0.0001	0.000019	0.00	0.00003	0.00023	0.12	0.02	30
Tetrachloroethene	4.06	7	0	0.0002	0.00002	0.00	0.000035	0.00026	0.075	0.03	81,000
Toluene	430.5	5700	8	0.0172	0.002172	0.23	0.026753	0.027	2000	21.56	89,000
Chlorobenzene	401.3	620	7	0.0161	0.002024	0.02	0.003128	0.025	20	2.35	11,000
Ethylbenzene	242.6	2000	4	0.0097	0.001224	0.08	0.010089	0.0153	1000	7.56	100,000
Xylena	1288	17000	23	0.0515	0.006497	0.68	0.085758	0.061	300	64.30	100,000

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Thermal Desorption Air Emissions Estimate
Weston Unit – 20 Tons per Hour Throughput

Compound	95th % UCL Concentration in Soil (ug/kg)	Maximum Concentration in Soil (ug/kg)	Average Mass Throughput (grams per hour)	Average Potential Emissions (lb/hr)	Average Potential Emissions (g/sec)	Maximum Potential Emissions (lb/hr)	Maximum Potential Emissions (g/sec)	Adjusted Annual Concentration (ug/m3)	AGC (ug/m3)	Maximum Short–term Concentration (ug/m3)	SGC (ug/m3)
Semivolatiles											
Phenol	839.02	14000	15	0.0338	0.004232	0.56	0.070622	0.053	9.6	52.95	4500
2–Nitrophenol	377.51	1300	7	0.0151	0.001904	0.05	0.006558	0.024		4.92	
Benzoic acid	1188.69	1500	22	0.0475	0.005998	0.06	0.007567	0.075		5.67	
Naphthalene	509.52	2500	9	0.0204	0.00257	0.10	0.012811	0.032	120	9.46	12000
2–Methylnaphthalene	662.47	3600	12	0.0265	0.003342	0.14	0.01816	0.042		13.62	
Acenaphthylene	241.47	510	4	0.0097	0.001218	0.02	0.002573	0.0152		1.93	
Acenaphthena	391.29	14000	7	0.0157	0.001974	0.56	0.070622	0.025		52.95	
4–Nitrophenol	642.03	1600	12	0.0257	0.003239	0.06	0.008071	0.040	0.1	6.05	–
Dibenzofuran	1739.79	7000	32	0.0696	0.008776	0.28	0.035311	0.110		26.48	
2,4–Dinitrotoluene	399.63	2000	7	0.0160	0.002018	0.08	0.010089	0.025		7.56	
Fluorene	402.04	12000	7	0.0161	0.002028	0.48	0.060533	0.025		45.39	
N–Nitrosodiphenylamine (1	199.68	450	4	0.0080	0.001007	0.02	0.00227	0.0126		1.70	
Phenanthrene	428.94	43000	8	0.0172	0.002164	1.72	0.216911	0.027		162.64	
Anthracene	390.72	15000	7	0.0156	0.001971	0.60	0.075667	0.025		56.73	
Di–n–butylphthalate	385.17	25000	7	0.0154	0.001943	1.00	0.126111	0.024		94.56	
Fluoranthene	446.45	29000	8	0.0179	0.002252	1.16	0.146289	0.028		109.69	
Pyrene	411.67	24000	7	0.0165	0.002077	0.96	0.121067	0.026		90.78	
Benzo(a)anthracene	407.73	9600	7	0.0163	0.002057	0.38	0.048427	0.026		36.31	
Chrysene	388.98	9900	7	0.0156	0.001962	0.40	0.04994	0.025		37.45	
bis(2–Ethylhexyl)phthalate	462.01	230000	8	0.0185	0.002331	9.20	1.160222	0.029		869.93	
Di–n–octylphthalate	189.49	430	3	0.0076	0.000956	0.02	0.002169	0.0119		1.63	
Benzo(b)fluoranthene	408.80	9500	7	0.0164	0.002062	0.38	0.047922	0.026		35.93	
benzo(k)fluoranthene	389.87	6700	7	0.0156	0.001967	0.27	0.033798	0.025		25.34	
Benzo(a)pyrene	395.96	9000	7	0.0158	0.001997	0.36	0.0454	0.025	0.002	34.04	–
Indeno(1,2,3–cd)pyrene	388.30	48000	7	0.0155	0.001949	1.92	0.242133	0.024		181.55	
Dibenz(a,h)anthracene	388.17	2100	7	0.0155	0.001956	0.08	0.010593	0.024		7.94	
Benzo(g,h,i)perylene	375.41	5000	7	0.0150	0.001894	0.20	0.025222	0.024		18.91	

Thermal Desorption Air Emissions Estimate
Weston Unit – 20 Tons per Hour Throughput

Compound	95th % UCL Concentration in Soil (ug/kg)	Maximum Concentration in Soil (ug/kg)	Average Mass Throughput (grams per hour)	Average Potential Emissions (lb/hr)	Average Potential Emissions (g/sec)	Maximum Potential Emissions (lb/hr)	Maximum Potential Emissions (g/sec)	Adjusted Annual Concentration (ug/m3)	AGC (ug/m3)	Maximum Short-term Concentration (ug/m3)	SGC (ug/m3)
Pesticides/PCBs											
Heptachlor	6.48	14	0	0.0003	0.000033	0.00	0.000071	0.00041	0.0008	0.05	5
Dieldrin	12.97	48	0	0.0005	0.000065	0.00	0.000232	0.00082		0.17	
4,4'-DDE	30.04	290	1	0.0012	0.000152	0.01	0.001463	0.00189		1.10	
4,4'-DDD	16.64	350	0	0.0007	0.000084	0.01	0.001766	0.00105		1.32	
4,4'-DDT	20.69	260	0	0.0008	0.000104	0.01	0.001312	0.00130		0.98	
Aroclor-1242	67.32	260	1	0.0027	0.00034	0.01	0.001312	0.00424	0.00045	0.98	0.1
Aroclor-1260	200.04	770	4	0.0080	0.001009	0.03	0.003884	0.01261	0.00045	2.91	0.1
Herbicides											
2,4-DB	50.72	410	1	0.0020	0.000256	0.02	0.002068	0.0032		1.55	
2,4,5-TP (Silvex)	2.93	10	0	0.0001	0.000015	0.00	0.00005	0.00018		0.04	
MCPP	2943.40	24000	54	0.1177	0.014848	0.96	0.121067	0.188		90.78	

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Thermal Desorption Air Emissions Estimate
Canonie Unit – 20 Tons per Hour Throughput

Compound	95th % UCL Concentration In Soil (ug/kg)	Maximum Concentration In Soil (ug/kg)	Average Mass Throughput (grams per hour)	Average Potential Emissions (lb/hr)	Average Potential Emissions (g/sec)	Maximum Potential Emissions (lb/hr)	Maximum Potential Emissions (g/sec)	Adjusted Annual Concentration (ug/m3)	AGC (ug/m3)	Maximum Short–term Concentration (ug/m3)	SGC (ug/m3)
Volatiles											
Vinyl chloride	799.8	1000	15	0.0320	0.004035	0.04	0.005044	0.006	0.02	0.42	1300
Acetone	378.7	680	7	0.0151	0.00191	0.03	0.00343	0.003	14000	0.28	140,000
Carbon disulfide	159.7	120	3	0.0064	0.000806	0.00	0.000605	0.0011	7	0.05	710
1,1–Dichloroethene	161.63	140	3	0.0065	0.000815	0.01	0.000706	0.0011	0.02	0.06	2,000
1,2–Dichloroethene (total)	7668	79000	139	0.3067	0.038681	3.16	0.398511	0.053	1900	32.96	190,000
Chloroform	11.58	32	0	0.0005	0.000058	0.00	0.000161	0.0001	23	0.01	980
1,2–Dichloroethane	149.2	210	3	0.0060	0.000753	0.01	0.001059	0.0010	0.039	0.09	950
2–Butanone	15.76	22	0	0.0006	0.00008	0.00	0.000111	0.00011	300	0.01	140,000
Trichloroethene	42351	540000	770	1.6940	0.213637	21.60	2.724	0.294	0.45	225.30	33,000
Benzene	3.72	6	0	0.0001	0.000019	0.00	0.00003	0.00003	0.12	0.00	30
Tetrachloroethene	4.06	7	0	0.0002	0.00002	0.00	0.000035	0.00003	0.075	0.00	81,000
Toluene	430.5	5700	8	0.0172	0.002172	0.23	0.028753	0.003	2000	2.38	89,000
Chlorobenzene	401.3	620	7	0.0161	0.002024	0.02	0.003126	0.003	20	0.26	11,000
Ethylbenzene	242.6	2000	4	0.0097	0.001224	0.08	0.010089	0.0017	1000	0.83	100,000
Xylene	1288	17000	23	0.0515	0.006497	0.68	0.065756	0.009	300	7.09	100,000

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LANDCAN.WK3

Thermal Desorption Air Emissions Estimate
Canonie Unit – 20 Tons per Hour Throughput

Compound	95th % UCL Concentration in Soil (ug/kg)	Maximum Concentration in Soil (ug/kg)	Average Mass Throughput (grams per hour)	Average Potential Emissions (lb/hr)	Average Potential Emissions (g/sec)	Maximum Potential Emissions (lb/hr)	Maximum Potential Emissions (g/sec)	Adjusted Annual Concentration (ug/m3)	AGC (ug/m3)	Maximum Short–term Concentration (ug/m3)	SGC (ug/m3)
Semivolatiles											
Phenol	839.02	14000	15	0.0336	0.004232	0.56	0.070622	0.006	9.6	5.84	4500
2–Nitrophenol	377.51	1300	7	0.0151	0.001904	0.05	0.006558	0.003		0.54	
Benzoic acid	1188.69	1500	22	0.0475	0.005996	0.06	0.007567	0.008		0.63	
Naphthalene	509.52	2500	9	0.0204	0.00257	0.10	0.012611	0.004	120	1.04	12000
2–Methylnaphthalene	662.47	3600	12	0.0265	0.003342	0.14	0.01816	0.005		1.50	
Acenaphthylene	241.47	510	4	0.0097	0.001218	0.02	0.002573	0.0017		0.21	
Acenaphthene	391.29	14000	7	0.0157	0.001974	0.56	0.070622	0.003		5.84	
4–Nitrophenol	642.03	1600	12	0.0257	0.003239	0.06	0.008071	0.004	0.1	0.67	–
Dibenzofuran	1739.79	7000	32	0.0696	0.008778	0.28	0.035311	0.012		2.92	
2,4–Dinitrotoluene	399.63	2000	7	0.0160	0.002018	0.08	0.010089	0.003		0.83	
Fluorene	402.04	12000	7	0.0161	0.002028	0.48	0.060533	0.003		5.01	
N–Nitrosodiphenylamine (1)	199.68	450	4	0.0080	0.001007	0.02	0.00227	0.0014		0.19	
Phenanthrene	428.94	43000	8	0.0172	0.002164	1.72	0.216911	0.003		17.94	
Anthracene	390.72	15000	7	0.0156	0.001971	0.60	0.075667	0.003		6.26	
Di–n–butylphthalate	385.17	25000	7	0.0154	0.001943	1.00	0.126111	0.003		10.43	
Fluoranthene	446.45	29000	8	0.0179	0.002252	1.16	0.146289	0.003		12.10	
Pyrene	411.67	24000	7	0.0165	0.002077	0.96	0.121067	0.003		10.01	
Benzo(a)anthracene	407.73	9600	7	0.0163	0.002057	0.38	0.048427	0.003		4.01	
Chrysene	388.98	9900	7	0.0156	0.001962	0.40	0.04994	0.003		4.13	
bis(2–Ethylhexyl)phthalate	462.01	230000	8	0.0185	0.002331	9.20	1.160222	0.003		95.96	
Di–n–octylphthalate	189.49	430	3	0.0076	0.000956	0.02	0.002169	0.0013		0.18	
Benzo(b)fluoranthene	408.80	9500	7	0.0164	0.002062	0.38	0.047922	0.003		3.96	
benzo(k)fluoranthene	389.87	6700	7	0.0156	0.001967	0.27	0.033798	0.003		2.80	
Benzo(a)pyrene	395.96	9000	7	0.0158	0.001997	0.36	0.0454	0.003	0.002	3.76	–
Indeno(1,2,3–cd)pyrene	386.30	48000	7	0.0155	0.001949	1.92	0.242133	0.003		20.03	
Dibenz(a,h)anthracene	388.17	2100	7	0.0155	0.001958	0.08	0.010593	0.003		0.88	
Benzo(g,h,i)perylene	375.41	5000	7	0.0150	0.001894	0.20	0.025222	0.003		2.09	

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Thermal Desorption Air Emissions Estimate
Canonie Unit – 20 Tons per Hour Throughput

Compound	95th % UCL Concentration in Soil (ug/kg)	Maximum Concentration in Soil (ug/kg)	Average Mass Throughput (grams per hour)	Average Potential Emissions (lb/hr)	Average Potential Emissions (g/sec)	Maximum Potential Emissions (lb/hr)	Maximum Potential Emissions (g/sec)	Adjusted Annual Concentration (ug/m3)	AGC (ug/m3)	Maximum Short-term Concentration (ug/m3)	SGC (ug/m3)
Pesticides/PCBs											
Heptachlor	6.48	14	0	0.0003	0.000033	0.00	0.000071	0.00005	0.0008	0.01	5
Dieldrin	12.97	46	0	0.0005	0.000065	0.00	0.000232	0.00009		0.02	
4,4'-DDE	30.04	290	1	0.0012	0.000152	0.01	0.001463	0.00021		0.12	
4,4'-DDD	16.64	350	0	0.0007	0.000084	0.01	0.001768	0.00012		0.15	
4,4'-DDT	20.69	260	0	0.0008	0.000104	0.01	0.001312	0.00014		0.11	
Aroclor-1242	67.32	260	1	0.0027	0.00034	0.01	0.001312	0.00047	0.00045	0.11	0.1
Aroclor-1260	200.04	770	4	0.0080	0.001009	0.03	0.003884	0.00139	0.00045	0.32	0.1
Herbicides											
2,4-DB	50.72	410	1	0.0020	0.000258	0.02	0.002068	0.0004		0.17	
2,4,5-TP (Silvex)	2.93	10	0	0.0001	0.000015	0.00	0.00005	0.00002		0.00	
MCPP	2943.40	24000	54	0.1177	0.014848	0.96	0.121067	0.020		10.01	

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                                                                   10/13/93
                                                                   14:18:51
  **  SCREEN2 MODEL RUN  ***
 *** VERSION DATED 92245 ***

Seneca Army Depot - Ash Landfill  Unit 3 - Weston - Stack Height = 15 Feet

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =        POINT
   EMISSION RATE (G/S)      =      1.00000
   STACK HEIGHT (M)         =       4.5720
   STK INSIDE DIAM (M)      =        .2032
   STK EXIT VELOCITY (M/S)=        20.3744
   STK GAS EXIT TEMP (K)    =     294.0000
   AMBIENT AIR TEMP (K)     =     293.0000
   RECEPTOR HEIGHT (M)      =        .0000
   URBAN/RURAL OPTION       =        RURAL
   BUILDING HEIGHT (M)      =       2.4380
   MIN HORIZ BLDG DIM (M) =         4.5720
   MAX HORIZ BLDG DIM (M) =         9.1440

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    1400.0000     (ACFM)

BUOY. FLUX =      .007 M**4/S**3;  MOM. FLUX =    4.270 M**4/S**2.

*** FULL METEOROLOGY ***

 ***********************************
 *** SCREEN AUTOMATED DISTANCES ***
***********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

 DIST      CONC             U10M   USTK   MIX HT   PLUME   SIGMA   SIGMA
  (M)    (UG/M**3)   STAB   (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   100.   612.1        3     2.0    2.0   640.0   10.78   12.59    7.65    NO
   200.   637.3        5     1.0    1.0 10000.0   12.80   11.86    6.67    NO
   300.   755.0        5     1.0    1.0 10000.0   12.80   17.06    9.01    NO
   400.   763.5        6     1.0    1.0 10000.0   12.07   14.79    7.37    NO
   500.   769.8        6     1.0    1.0 10000.0   12.07   18.09    8.66    NO
   600.   717.3        6     1.0    1.0 10000.0   12.07   21.34    9.92    NO
   700.   647.3        6     1.0    1.0 10000.0   12.07   24.55   11.14    NO
   800.   577.2        6     1.0    1.0 10000.0   12.07   27.72   12.17    NO
   900.   514.9        6     1.0    1.0 10000.0   12.07   30.85   13.16    NO
  1000.   460.9        6     1.0    1.0 10000.0   12.07   33.95   14.12    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND    100. M:
   453.   778.0        6     1.0    1.0 10000.0   12.07   16.58    8.07    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
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 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*********************************
  *  SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------   ----  -----  -----  ------  ------  ------  ------  -----
    61.   670.6         4     8.0    8.0  2560.0    6.12    5.20    4.48   HS

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------   ----  -----  -----  ------  ------  ------  ------  -----
   260.   749.8         5     1.0    1.0 10000.0   12.80   14.99    8.08   NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 ***********************************************
 *   SUMMARY OF TERRAIN HEIGHTS ENTERED FOR    *
 *     SIMPLE ELEVATED TERRAIN PROCEDURE       *
 ***********************************************

      TERRAIN       DISTANCE RANGE (M)
       HT (M)      MINIMUM     MAXIMUM
      -------     --------    --------
           0.         100.       1000.
           0.          61.         --
           0.         260.         --

 *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)       =    .0000        CONC (UG/M**3)       =    .0000
  CRIT WS @10M (M/S)   =    99.99        CRIT WS @10M (M/S)   =    99.99
  CRIT WS @ HS (M/S)   =    99.99        CRIT WS @ HS (M/S)   =    99.99
  DILUTION WS (M/S)    =    99.99        DILUTION WS (M/S)    =    99.99
  CAVITY HT (M)        =     2.78        CAVITY HT (M)        =     2.47
  CAVITY LENGTH (M)    =     6.70        CAVITY LENGTH (M)    =     5.45
  ALONGWIND DIM (M)    =     4.57        ALONGWIND DIM (M)    =     9.14

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
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     ****************************************

 CALCULATION           MAX CONC     DIST TO    TERRAIN
  PROCEDURE           (UG/M**3)     MAX (M)     HT (M)
 --------------      -----------    -------    -------
SIMPLE TERRAIN         778.0           453.         0.

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** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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                                                                  10/13/93
                                                                  14:20:32
  **  SCREEN2 MODEL RUN  ***
 *** VERSION DATED 92245 ***

Seneca Army Depot - Ash Landfill  Unit 3 - Weston - Stack Height = 21 Feet

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      1.00000
   STACK HEIGHT (M)       =       6.4008
   STK INSIDE DIAM (M)    =        .2032
   STK EXIT VELOCITY (M/S)=      20.3744
   STK GAS EXIT TEMP (K)  =     294.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =       2.4380
   MIN HORIZ BLDG DIM (M) =       4.5720
   MAX HORIZ BLDG DIM (M) =       9.1440

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =   1400.0000     (ACFM)

BUOY. FLUX =     .007 M**4/S**3;  MOM. FLUX =    4.270 M**4/S**2.

*** FULL METEOROLOGY ***

 **********************************
 *** SCREEN AUTOMATED DISTANCES ***
 **********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

 DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
  (M)   (UG/M**3)   STAB   (M/S)  (M/S)   (M)    HT (M)  Y (M)   Z (M)   DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   100.   434.6        3     2.5    2.5   800.0   11.37   12.54    7.58    NO
   200.   407.5        4     2.0    2.0   640.0   12.61   15.66    8.68    NO
   300.   554.3        5     1.0    1.0 10000.0   14.63   17.06    9.01    NO
   400.   542.3        5     1.0    1.0 10000.0   14.63   22.14   11.07    NO
   500.   561.1        6     1.0    1.0 10000.0   13.90   18.09    8.66    NO
   600.   563.6        6     1.0    1.0 10000.0   13.90   21.34    9.92    NO
   700.   534.5        6     1.0    1.0 10000.0   13.90   24.55   11.14    NO
   800.   491.6        6     1.0    1.0 10000.0   13.90   27.72   12.17    NO
   900.   449.0        6     1.0    1.0 10000.0   13.90   30.85   13.16    NO
  1000.   409.1        6     1.0    1.0 10000.0   13.90   33.95   14.12    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   552.   568.0        6     1.0    1.0 10000.0   13.90   19.82    9.33    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
```

```
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 ***********************************
 *** SCREEN DISCRETE DISTANCES ***
 ***********************************

 *** TERRAIN HEIGHT OF     0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST       CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
    (M)    (UG/M**3)    STAB   (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
 -------  ----------    ----   -----  -----  ------   ------  ------  ------  -----
     61.    380.1         2     3.0    3.0   960.0    10.54   12.33    6.79   NO

 ***********************************
 *** SCREEN DISCRETE DISTANCES ***
 ***********************************

 *** TERRAIN HEIGHT OF     0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST       CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
    (M)    (UG/M**3)    STAB   (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
 -------  ----------    ----   -----  -----  ------   ------  ------  ------  -----
    260.    510.8         5     1.0    1.0 10000.0    14.63   14.99    8.08   NO

  DWASH=   MEANS NO CALC MADE (CONC = 0.0)
  DWASH=NO MEANS NO BUILDING DOWNWASH USED
  DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
  DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

  ********************************************
  *  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR  *
  *    SIMPLE ELEVATED TERRAIN PROCEDURE     *
  ********************************************

       TERRAIN       DISTANCE RANGE (M)
        HT (M)      MINIMUM     MAXIMUM
       -------      --------    --------
            0.         100.       1000.
            0.          61.         --
            0.         260.         --

  *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
   CONC (UG/M**3)       =    .0000       CONC (UG/M**3)       =    .0000
   CRIT WS @10M (M/S) =    99.99         CRIT WS @10M (M/S) =    99.99
   CRIT WS @ HS (M/S) =    99.99         CRIT WS @ HS (M/S) =    99.99
   DILUTION WS (M/S)  =    99.99         DILUTION WS (M/S)  =    99.99
   CAVITY HT (M)      =     2.78         CAVITY HT (M)      =     2.47
   CAVITY LENGTH (M)  =     6.70         CAVITY LENGTH (M)  =     5.45
   ALONGWIND DIM (M)  =     4.57         ALONGWIND DIM (M)  =     9.14

 CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
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     ***************************************

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      568.0          552.        0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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15/20

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                                                                        10/14/93
                                                                        16:35:16
   *  SCREEN2 MODEL RUN  ***
 *** VERSION DATED 92245 ***

 Seneca Army Depot - Ash Landfill  Unit 1 - Canonie - Stack Height = 15 Feet

 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE              =        POINT
    EMISSION RATE (G/S)      =      1.00000
    STACK HEIGHT (M)         =       4.5720
    STK INSIDE DIAM (M)      =        .6700
    STK EXIT VELOCITY (M/S)=        36.5708
    STK GAS EXIT TEMP (K)    =     310.7780
    AMBIENT AIR TEMP (K)     =     293.0000
    RECEPTOR HEIGHT (M)      =        .0000
    URBAN/RURAL OPTION       =        RURAL
    BUILDING HEIGHT (M)      =       2.4380
    MIN HORIZ BLDG DIM (M)   =       4.5720
    MAX HORIZ BLDG DIM (M)   =       9.1440

    STACK EXIT VELOCITY WAS CALCULATED FROM
    VOLUME FLOW RATE =    27320.000      (ACFM)

 BUOY. FLUX =     2.302 M**4/S**3;  MOM. FLUX =  141.507 M**4/S**2.

 *** FULL METEOROLOGY ***

    *********************************
 *** SCREEN AUTOMATED DISTANCES ***
 **********************************

 *** TERRAIN HEIGHT OF     0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST      CONC             U10M    USTK   MIX HT   PLUME    SIGMA    SIGMA
   (M)    (UG/M**3)   STAB   (M/S)   (M/S)    (M)    HT (M)   Y (M)    Z (M)   DWASH
 -------  ----------  ----   -----   -----  ------   ------   ------   ------   -----
    100.    99.22       3     10.0    10.0  3200.0    11.92    12.64     7.73    NO
    200.    91.59       4     10.0    10.0  3200.0    11.92    15.70     8.75    NO
    300.    76.12       4      8.0     8.0  2560.0    13.76    22.76    12.37    NO
    400.    64.43       4      5.0     5.0  1600.0    19.27    29.75    15.84    NO
    500.    55.68       4      4.5     4.5  1440.0    20.91    36.45    18.88    NO
    600.    48.80       4      3.5     3.5  1120.0    25.57    43.14    22.04    NO
    700.    43.48       4      3.5     3.5  1120.0    25.57    49.55    24.77    NO
    800.    42.70       5      1.0     1.0 10000.0    43.82    43.03    21.44    NO
    900.    46.82       5      1.0     1.0 10000.0    43.82    47.61    22.90    NO
   1000.    49.70       5      1.0     1.0 10000.0    43.82    52.16    24.36    NO

 MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
    109.    100.3       3     10.0    10.0  3200.0    11.92    13.77     8.39    NO

  DWASH=   MEANS NO CALC MADE (CONC = 0.0)
  DWASH=NO MEANS NO BUILDING DOWNWASH USED
  DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
   WASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
   WASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *********************************
 *** SCREEN DISCRETE DISTANCES ***
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**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK   MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)   DWASH
 -------  ----------  ----  -----  -----  ------   ------   ------  ------  -----
    61.   52.59         3    10.0   10.0  3200.0   11.92     8.15    5.16    NO

**********************************
*** SCREEN DISCRETE DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK   MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)   DWASH
 -------  ----------  ----  -----  -----  ------   ------   ------  ------  -----
   260.   82.71         4     8.0    8.0  2560.0   13.76    19.99   11.00    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 ********************************************
 *  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR  *
 *     SIMPLE ELEVATED TERRAIN PROCEDURE    *
 ********************************************

      TERRAIN       DISTANCE RANGE (M)
       HT (M)      MINIMUM     MAXIMUM
      -------     --------    --------
           0.         100.       1000.
           0.          61.         --
           0.         260.         --

 *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)        =    .0000      CONC (UG/M**3)        =    .0000
  CRIT WS @10M (M/S)    =    99.99      CRIT WS @10M (M/S)    =    99.99
  CRIT WS @ HS (M/S)    =    99.99      CRIT WS @ HS (M/S)    =    99.99
  DILUTION WS (M/S)     =    99.99      DILUTION WS (M/S)     =    99.99
  CAVITY HT (M)         =     2.78      CAVITY HT (M)         =     2.47
  CAVITY LENGTH (M)     =     6.70      CAVITY LENGTH (M)     =     5.45
  ALONGWIND DIM (M)     =     4.57      ALONGWIND DIM (M)     =     9.14

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION          MAX CONC     DIST TO   TERRAIN
  PROCEDURE          (UG/M**3)     MAX (M)    HT (M)
 ------------       ----------     -------   -------
 IMPLE TERRAIN        100.3          109.        0.

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                                                                  10/14/93
                                                                  16:34:52
   *   SCREEN2 MODEL RUN   ***
 *** VERSION DATED 92245 ***

Seneca Army Depot - Ash Landfill  Unit 1 - Canonie - Stack Height = 25 Feet

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =        POINT
   EMISSION RATE (G/S)      =      1.00000
   STACK HEIGHT (M)         =       7.6200
   STK INSIDE DIAM (M)      =        .6700
   STK EXIT VELOCITY (M/S)=        36.5708
   STK GAS EXIT TEMP (K)    =     310.7780
   AMBIENT AIR TEMP (K)     =     293.0000
   RECEPTOR HEIGHT (M)      =        .0000
   URBAN/RURAL OPTION       =        RURAL
   BUILDING HEIGHT (M)      =       2.4380
   MIN HORIZ BLDG DIM (M)   =       4.5720
   MAX HORIZ BLDG DIM (M)   =       9.1440

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    27320.000     (ACFM)

BUOY. FLUX =    2.302 M**4/S**3;  MOM. FLUX =  141.507 M**4/S**2.

*** FULL METEOROLOGY ***

  **********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK   MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)   STAB   (M/S)  (M/S)    (M)    HT (M)  Y (M)   Z (M)   DWASH
-------  ----------   ----   -----  -----   ------  ------  ------  ------  -----
   100.    49.99         3   10.0   10.0   3200.0   14.97   12.64    7.73    NO
   200.    58.63         3    8.0    8.0   2560.0   16.81   23.77   14.27    NO
   300.    56.15         4    8.0    8.0   2560.0   16.81   22.76   12.37    NO
   400.    50.04         4    5.0    5.0   1600.0   22.32   29.75   15.84    NO
   500.    45.97         4    4.5    4.5   1440.0   23.95   36.45   18.88    NO
   600.    41.70         4    4.0    4.0   1280.0   26.00   43.04   21.85    NO
   700.    38.01         4    3.5    3.5   1120.0   28.62   49.55   24.77    NO
   800.    34.90         4    3.0    3.0    960.0   32.12   56.01   27.68    NO
   900.    35.98         5    1.0    1.0  10000.0   46.87   47.61   22.90    NO
  1000.    39.37         5    1.0    1.0  10000.0   46.87   52.16   24.36    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   142.    63.02         3   10.0   10.0   3200.0   14.97   17.47   10.53    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  WASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

**********************************
*** SCREEN DISCRETE DISTANCES ***
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*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST      CONC              U10M    USTK   MIX HT    PLUME    SIGMA    SIGMA
    (M)    (UG/M**3)    STAB   (M/S)   (M/S)    (M)     HT (M)   Y (M)    Z (M)   DWASH
 -------  ----------    ----   -----   -----  ------    ------   ------   ------  -----
    61.     11.31         3     10.0    10.0  3200.0    14.97     8.15     5.16    NO

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST      CONC              U10M    USTK   MIX HT    PLUME    SIGMA    SIGMA
    (M)    (UG/M**3)    STAB   (M/S)   (M/S)    (M)     HT (M)   Y (M)    Z (M)   DWASH
 -------  ----------    ----   -----   -----  ------    ------   ------   ------  -----
   260.     56.97         4     10.0    10.0  3200.0    14.97    19.93    10.88    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 ********************************************
 *  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR  *
 *     SIMPLE ELEVATED TERRAIN PROCEDURE    *
 ********************************************

      TERRAIN      DISTANCE RANGE (M)
       HT (M)     MINIMUM    MAXIMUM
      -------    --------   --------
          0.        100.      1000.
          0.         61.        --
          0.        260.        --

 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)      =    .0000       CONC (UG/M**3)      =    .0000
  CRIT WS @10M (M/S)  =    99.99       CRIT WS @10M (M/S)  =    99.99
  CRIT WS @ HS (M/S)  =    99.99       CRIT WS @ HS (M/S)  =    99.99
  DILUTION WS (M/S)   =    99.99       DILUTION WS (M/S)   =    99.99
  CAVITY HT (M)       =     2.78       CAVITY HT (M)       =     2.47
  CAVITY LENGTH (M)   =     6.70       CAVITY LENGTH (M)   =     5.45
  ALONGWIND DIM (M)   =     4.57       ALONGWIND DIM (M)   =     9.14

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION          MAX CONC      DIST TO    TERRAIN
  PROCEDURE          (UG/M**3)      MAX (M)     HT (M)
 ------------       ----------      -------    -------
SIMPLE TERRAIN         63.02           142.         0.

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** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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APPENDIX B

Risk Assessment Tables

Baseline Risk Case

BASELINE
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																Child(Nc)	Adult(Nc)	Car
Volatile Organics																		
Vinyl Chloride	2.5E-08		1.8E-08		7.5E-09	1.60E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dichloroethene, 1,2- (total)		7.5E-06		8.0E-07		5.84E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trichloroethene	2.5E-06		1.7E-06		7.5E-07	1.59E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Semi-volatiles																		
Methylnaphthalene, 2-						3.60E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Acenaphthylene						2.51E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzofuran						4.08E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene						1.05E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.4E-06		1.0E-06		4.3E-07	9.16E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
bis(2-Ethylhexyl)phthalate	1.5E-06	1.3E-05	1.1E-06	1.4E-06	4.6E-07	9.88E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.3E-06		9.1E-07		3.9E-07	8.33E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.1E-06		7.8E-07		3.3E-07	7.12E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.4E-06		9.6E-07		4.1E-07	8.76E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	9.9E-07		7.0E-07		3.0E-07	6.35E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	7.3E-07		5.1E-07		2.2E-07	4.66E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene						6.81E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCB's																		
Aroclor-1260	2.5E-07		1.8E-07		7.6E-08	1.61E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																		
Cadmium		7.1E-05		7.6E-06		5.53E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium VI		3.9E-04		4.2E-05		3.06E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper		9.1E-04		9.8E-05		7.16E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead						2.65E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc		2.0E-02		2.2E-03		1.58E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)/ 200 (Child)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	350 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)/ 15 (Child 6-7)
AT = Averaging Time (days)	6 x 365 Child 24 x 365 Adult (NC)
	70 x 365 (C)

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Vinyl Chloride			2.5E-08	NA	1.9E+00				4.8E-08
Dichloroethene, 1,2- (total)	8.00E-07	7.5E-06		9.0E-03	NA	8.9E-05	8.3E-04	9.2E-04	
Trichloroethene			2.5E-06	NA	1.1E-02				2.7E-08
Semi-volatiles									
Methylnaphthalene, 2-				NA	NA				
Acenaphthylene				NA	NA				
Dibenzofuran				NA	NA				
Phenanthrene				NA	NA				
Benzo(a)anthracene			1.4E-06	NA	7.3E-01				1.0E-06
bis(2-Ethylhexyl)phthalate	1.35E-06	1.3E-05	1.5E-06	2.0E-02	1.4E-02	6.8E-05	6.3E-04	7.0E-04	2.2E-08
Benzo(b)fluoranthene			1.3E-06	NA	7.3E-01				9.5E-07
Benzo(k)fluoranthene			1.1E-06	NA	7.3E-01				8.1E-07
Benzo(a)pyrene			1.4E-06	NA	7.3E+00				1.0E-05
Indeno(1,2,3-cd)pyrene			9.9E-07	NA	7.3E-01				7.3E-07
Dibenzo(a,h)anthracene			7.3E-07	NA	7.3E+00				5.3E-06
Benzo(g,h,i)perylene				NA	NA				
Pesticides/PCB's									
Aroclor-1260			2.5E-07	NA	7.7E+00				1.9E-06
Metals									
Cadmium	7.58E-06	7.1E-05		5.0E-04	NA	1.5E-02	1.4E-01	1.6E-01	
Chromium VI	4.19E-05	3.9E-04		5.0E-03	NA	8.4E-03	7.8E-02	8.6E-02	
Copper	9.80E-05	9.1E-04		4.0E-02	NA	2.5E-03	2.3E-02	2.5E-02	
Lead				NA	NA				
Zinc	2.16E-03	2.0E-02		3.0E-01	NA	7.2E-03	6.7E-02	7.5E-02	
Totals - HQ & CR								**3.4E-01**	**2.1E-05**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics											
Vinyl Chloride		1.3E-08	6.25E-02	100	1.0E-06	1	150	25	70	9,125	25,550
Dichloroethene, 1,2- (total)	1.0E-06		1.71E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Trichloroethene		4.8E-07	2.27E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Semi-volatiles											
Methylnaphthalene, 2-			4.41E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Acenaphthylene			2.65E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzofuran			3.98E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			6.58E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		1.1E-07	5.20E-01	100	1.0E-06	1	150	25	70	9,125	25,550
bis(2-Ethylhexyl)phthalate	4.2E-07	1.5E-07	7.15E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		1.0E-07	4.98E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		9.8E-08	4.69E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		1.0E-07	4.91E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		9.0E-08	4.31E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		8.6E-08	4.11E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			4.31E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Aroclor-1260		3.3E-08	1.57E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Cadmium	2.3E-06		3.84E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Chromium VI	1.6E-05		2.77E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Copper	2.4E-05		4.05E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Lead			9.00E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Zinc	2.4E-04		4.09E+02	100	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	150 events/year
ED = Exposure Duration (years)	25 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.3E-08	NA	1.9E+00		2.5E-08
Dichloroethene, 1,2- (total)	1.0E-06		9.0E-03	NA	1.1E-04	
Trichloroethene		4.8E-07	NA	1.1E-02		5.2E-09
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		1.1E-07	NA	7.3E-01		8.0E-08
bis(2-Ethylhexyl)phthalate	4.2E-07	1.5E-07	2.0E-02	1.4E-02	2.1E-05	2.1E-09
Benzo(b)fluoranthene		1.0E-07	NA	7.3E-01		7.6E-08
Benzo(k)fluoranthene		9.8E-08	NA	7.3E-01		7.2E-08
Benzo(a)pyrene		1.0E-07	NA	7.3E+00		7.5E-07
Indeno(1,2,3-cd)pyrene		9.0E-08	NA	7.3E-01		6.6E-08
Dibenzo(a,h)anthracene		8.6E-08	NA	7.3E+00		6.3E-07
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		3.3E-08	NA	7.7E+00		2.5E-07
Metals						
Cadmium	2.3E-06		5.0E-04	NA	4.5E-03	
Chromium VI	1.6E-05		5.0E-03	NA	3.3E-03	
Copper	2.4E-05		4.0E-02	NA	5.9E-04	
Lead			NA	NA		
Zinc	2.4E-04		3.0E-01	NA	8.0E-04	
Totals - HQ & CR					**9.3E-03**	**2.0E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		2.7E-10	1.60E-02	100	1.0E-06	1	10	30	70	10,950	25,550
Dichloroethene, 1,2- (total)	2.3E-08		5.84E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Trichloroethene		2.7E-08	1.59E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Semi-volatiles											
Methylnaphthalene, 2-			3.60E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Acenaphthylene			2.51E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzofuran			4.08E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Phenanthrene			1.05E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)anthracene		1.5E-08	9.16E-01	100	1.0E-06	1	10	30	70	10,950	25,550
bis(2-Ethylhexyl)phthalate	3.9E-08	1.7E-08	9.88E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(b)fluoranthene		1.4E-08	8.33E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(k)fluoranthene		1.2E-08	7.12E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)pyrene		1.5E-08	8.76E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene		1.1E-08	6.35E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzo(a,h)anthracene		7.8E-09	4.66E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(g,h,i)perylene			6.81E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Pesticides/PCB's											
Aroclor-1260		2.7E-09	1.61E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Metals											
Cadmium	2.2E-07		5.53E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Chromium VI	1.2E-06		3.06E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Copper	2.8E-06		7.16E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Lead			2.65E+02	100	1.0E-06	1	10	30	70	10,950	25,550
Zinc	6.2E-05		1.58E+03	100	1.0E-06	1	10	30	70	10,950	25,550

Intake (mg/kg-day) =

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	10 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

09/12/94

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		2.7E-10	NA	1.9E+00		5.1E-10
Dichloroethene, 1,2- (total)	2.3E-08		9.0E-03	NA	2.5E-06	
Trichloroethene		2.7E-08	NA	1.1E-02		2.9E-10
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		1.5E-08	NA	7.3E-01		1.1E-08
bis(2-Ethylhexyl)phthalate	3.9E-08	1.7E-08	2.0E-02	1.4E-02	1.9E-06	2.3E-10
Benzo(b)fluoranthene		1.4E-08	NA	7.3E-01		1.0E-08
Benzo(k)fluoranthene		1.2E-08	NA	7.3E-01		8.7E-09
Benzo(a)pyrene		1.5E-08	NA	7.3E+00		1.1E-07
Indeno(1,2,3-cd)pyrene		1.1E-08	NA	7.3E-01		7.8E-09
Dibenzo(a,h)anthracene		7.8E-09	NA	7.3E+00		5.7E-08
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		2.7E-09	NA	7.7E+00		2.1E-08
Metals						
Cadmium	2.2E-07		5.0E-04	NA	4.3E-04	
Chromium VI	1.2E-06		5.0E-03	NA	2.4E-04	
Copper	2.8E-06		4.0E-02	NA	7.0E-05	
Lead			NA	NA		
Zinc	6.2E-05		3.0E-01	NA	2.1E-04	
Totals - HQ & CR					**9.5E-04**	**2.2E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE
CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		1.7E-07	1.61E-01	1.0E-06	5,000	1.0	0.1	150	25	70	9,125	25,550
Metals												
Cadmium	1.6E-06		5.53E+00	1.0E-06	5,000	1.0	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) =

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)	EF = Exposure Frequency (days/year)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm²)	5000(A)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1.00	AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)
ABS = Absorption Factor (unitless)	varies EPA, 1992		

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		1.7E-07	NA	8.1E+00		1.4E-06
Metals						
Cadmium	1.6E-06		3.0E-05	NA	5.4E-02	
Totals - HQ & CR					**5.4E-02**	**1.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE
CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		5.4E-09	1.61E-01	1.0E-06	2,000	1.0	0.1	10	30	70	10,950	25,550
Metals												
Cadmium	4.3E-08		5.53E+00	1.0E-06	2,000	1.0	0.01	10	30	70	10,950	25,550

EQUATION:

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	10 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm²)	2000 cm² (Adult)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1	AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 Adult (Car)
ABS = Absorption Factor (unitless)	0.01		

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**CDI (Nc)** (mg/kg-day)	**CDI (Car)** (mg/kg-day)	**Dermal RfD** (mg/kg-day)	**Dermal Slope Factor** (mg/kg-day)-1	**Hazard Quotient**	**Cancer Risk**
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		5.4E-09	NA	8.1E+00		4.4E-08
Metals						
Cadmium	4.3E-08		3.0E-05	NA	1.4E-03	
Totals - HQ & CR					**1.4E-03**	**4.4E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE
CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm²)	Adult Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
<u>Volatile Organics</u>																			
<u>Semi-volatiles</u>																			
<u>Pesticides/PCB's</u>																			
Aroclor-1260	5.7E-07		1.9E-07		3.8E-07	1.61E-01	1.0E-06	2,165	5,000	1.0	0.1	350	6	24	15	70	2,190	8,760	25,550
<u>Metals</u>																			
Cadmium	0.0E+00	7.7E-06		3.8E-06		5.53E+00	1.0E-06	2,165	5,000	1.0	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) =

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

<u>Variables:</u>	<u>Assumptions:</u>	<u>Variables:</u>	<u>Assumptions:</u>
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm²)	2165(C)/5000(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1.00	AT = Averaging Time (days)	6 x 365 Child 24 x 365 Adult (Nc)
ABS = Absorption Factor (unitless)	varies EPA, 1992		70 x 365 (Car)

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Semi-volatiles									
Pesticides/PCB's									
Aroclor-1260			5.7E-07	NA	8.1E+00				4.6E-06
Metals									
Cadmium	3.8E-06	7.7E-06	0.0E+00	3.0E-05	NA	1.3E-01	2.6E-01	3.8E-01	
Totals - HQ & CR								**3.8E-01**	**4.6E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE

CALCULATION OF VOLATILE ORGANIC COMPOUNDS IN AMBIENT AIR
RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	Off-Site Conc. ug/m³	On-Site Conc. ug/m³	Average Emission Rate Ei g/s	Effective Diffusivity Dei cm²/s	Molecular Diffusivity Di cm²/s	Bulk Soil Concentration Ci g/g	Exposure Interval t sec.	Soil Porosity ε	Exposed Surface Area A cm²	Constant a	Soil/Air Partition Coef. Kas g/cm³
Volatile Organics											
Vinyl Chloride	0.374	1.575	5.4064E-04	0.074023	0.102103	4.4463E-07	9.10E+08	0.38	6.82E+07	2.98E-02	2.95
Chloroethane	0.000	0.001	4.4436E-07	0.0718	0.099037	3.0000E-09	9.10E+08	0.38	6.82E+07	1.20E-03	0.07
Acetone	0.017	0.073	2.5104E-05	0.071065	0.098023	3.3695E-07	9.10E+08	0.38	6.82E+07	3.11E-04	0.02
Carbon Disulfide	0.034	0.144	4.9281E-05	0.076044	0.10489	1.2350E-07	9.10E+08	0.38	6.82E+07	7.34E-03	0.47
1,1-Dichloroethene	0.059	0.247	8.4759E-05	0.062898	0.086758	1.4530E-07	9.10E+08	0.38	6.82E+07	1.24E-02	1.07
1,2-Dichloroethene (total)	10.273	43.318	1.4866E-02	0.062898	0.086758	6.0135E-05	9.10E+08	0.38	6.82E+07	3.12E-03	0.23
Chloroform	0.001	0.005	1.8063E-06	0.068672	0.094722	9.5379E-09	9.10E+08	0.38	6.82E+07	1.91E-03	0.13
1,2-Dichloroethane	0.015	0.061	2.1041E-05	0.061481	0.084803	1.0962E-07	9.10E+08	0.38	6.82E+07	1.95E-03	0.14
2-Butanone	0.000	0.002	6.8890E-07	0.061749	0.085173	1.2310E-08	9.10E+08	0.38	6.82E+07	1.76E-04	0.01
1,1,1-Trichloroethane	0.000	0.000	0.0000E+00	0.055018	0.075889	0.0000E+00	9.10E+08	0.38	6.82E+07	2.34E-03	0.19
Trichloroethene	9.952	41.965	1.4402E-02	0.056046	0.077306	7.7248E-05	9.10E+08	0.38	6.82E+07	1.84E-03	0.15
Benzene	0.000	0.002	6.2538E-07	0.06013	0.08294	3.3573E-09	9.10E+08	0.38	6.82E+07	1.84E-03	0.14
Tetrachloroethene	0.000	0.002	6.2679E-07	0.051194	0.070614	3.5449E-09	9.10E+08	0.38	6.82E+07	1.65E-03	0.15
Toluene	0.015	0.063	2.1625E-05	0.054111	0.074637	2.2028E-07	9.10E+08	0.38	6.82E+07	5.33E-04	0.04
Chlorobenzene	0.009	0.037	1.2678E-05	0.053528	0.073833	1.7862E-07	9.10E+08	0.38	6.82E+07	2.81E-04	0.02
Ethylbenzene	0.006	0.026	8.8219E-06	0.049563	0.068364	1.7960E-07	9.10E+08	0.38	6.82E+07	1.35E-04	0.01
Xylene (total)	0.039	0.163	5.6072E-05	0.049563	0.068364	5.0680E-07	9.10E+08	0.38	6.82E+07	6.72E-04	0.06

EQUATIONS:

Current Con. (ug/m³) =
Future Con. (ug/m³) =

Emission rate Ei (g/s) =

Effective Diffusivity Dei (cm²/s) =
Molecular Diffusivity Di (cm²/s) =

BASELINE

CALCULATION OF INTAKE (OFF-SITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		4.4E-05	3.74E-01	20	350	30	70	10,950	25,550
Chloroethane	8.4E-08		3.07E-04	20	350	30	70	10,950	25,550
Acetone			1.73E-02	20	350	30	70	10,950	25,550
Carbon Disulfide	9.3E-06		3.41E-02	20	350	30	70	10,950	25,550
1,1-Dichloroethene		6.9E-06	5.86E-02	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	2.8E-03		1.03E+01	20	350	30	70	10,950	25,550
Chloroform		1.5E-07	1.25E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethane	4.0E-06	1.7E-06	1.45E-02	20	350	30	70	10,950	25,550
2-Butanone	1.3E-07		4.76E-04	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		1.2E-03	9.95E+00	20	350	30	70	10,950	25,550
Benzene		5.1E-08	4.32E-04	20	350	30	70	10,950	25,550
Tetrachloroethene		5.1E-08	4.33E-04	20	350	30	70	10,950	25,550
Toluene	4.1E-06		1.49E-02	20	350	30	70	10,950	25,550
Chlorobenzene	2.4E-06		8.76E-03	20	350	30	70	10,950	25,550
Ethylbenzene	1.7E-06		6.10E-03	20	350	30	70	10,950	25,550
Xylene (total)			3.87E-02	20	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

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BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**CDI (Nc)** (mg/kg-day)	**CDI (Car)** (mg/kg-day)	**RfC** (mg/kg-day)	**Carc. Slope Inhalation** (mg/kg-day)-1	**Hazard Quotient**	**Cancer Risk**
Volatile Organics						
Vinyl Chloride		4.4E-05	NA	2.9E-01		1.3E-05
Chloroethane	8.4E-08		2.9E+00	NA	2.9E-08	
Acetone			NA	NA		
Carbon Disulfide	9.3E-06		2.9E-03	NA	3.3E-03	
1,1-Dichloroethene		6.9E-06	NA	1.2E+00		8.3E-06
1,2-Dichloroethene (total)	2.8E-03		1.2E+00	NA	2.3E-03	
Chloroform		1.5E-07	NA	8.1E-02		1.2E-08
1,2-Dichloroethane	4.0E-06	1.7E-06	2.9E-03	9.1E-02	1.4E-03	1.6E-07
2-Butanone	1.3E-07		2.9E-01	NA	4.6E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		1.2E-03	NA	6.0E-03		7.0E-06
Benzene		5.1E-08	NA	2.9E-02		1.5E-09
Tetrachloroethene		5.1E-08	NA	2.0E-03		1.0E-10
Toluene	4.1E-06		1.1E-01	NA	3.6E-05	
Chlorobenzene	2.4E-06		5.0E-03	NA	4.8E-04	
Ethylbenzene	1.7E-06		2.9E-01	NA	5.8E-06	
Xylene (total)			NA	NA		
Total HQ & CR					**7.5E-03**	**2.8E-05**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

BASELINE

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		1.8E-04	1.58E+00	20	350	30	70	10,950	25,550
Chloroethane	3.5E-07		1.29E-03	20	350	30	70	10,950	25,550
Acetone			7.32E-02	20	350	30	70	10,950	25,550
Carbon Disulfide	3.9E-05		1.44E-01	20	350	30	70	10,950	25,550
1,1-Dichloroethene		2.9E-05	2.47E-01	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	1.2E-02		4.33E+01	20	350	30	70	10,950	25,550
Chloroform		6.2E-07	5.26E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethane	1.7E-05	7.2E-06	6.13E-02	20	350	30	70	10,950	25,550
2-Butanone	5.5E-07		2.01E-03	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		4.9E-03	4.20E+01	20	350	30	70	10,950	25,550
Benzene		2.1E-07	1.82E-03	20	350	30	70	10,950	25,550
Tetrachloroethene		2.1E-07	1.83E-03	20	350	30	70	10,950	25,550
Toluene	1.7E-05		6.30E-02	20	350	30	70	10,950	25,550
Chlorobenzene	1.0E-05		3.69E-02	20	350	30	70	10,950	25,550
Ethylbenzene	7.0E-06		2.57E-02	20	350	30	70	10,950	25,550
Xylene (total)			1.63E-01	20	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

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BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.8E-04	NA	2.9E-01		5.4E-05
Chloroethane	3.5E-07		2.9E+00	NA	1.2E-07	
Acetone			NA	NA		
Carbon Disulfide	3.9E-05		2.9E-03	NA	1.4E-02	
1,1-Dichloroethene		2.9E-05	NA	1.2E+00		3.5E-05
1,2-Dichloroethene (total)	1.2E-02		1.2E+00	NA	9.9E-03	
Chloroform		6.2E-07	NA	8.1E-02		5.0E-08
1,2-Dichloroethane	1.7E-05	7.2E-06	2.9E-03	9.1E-02	5.8E-03	6.6E-07
2-Butanone	5.5E-07		2.9E-01	NA	1.9E-06	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		4.9E-03	NA	6.0E-03		3.0E-05
Benzene		2.1E-07	NA	2.9E-02		6.2E-09
Tetrachloroethene		2.1E-07	NA	2.0E-03		4.3E-10
Toluene	1.7E-05		1.1E-01	NA	1.5E-04	
Chlorobenzene	1.0E-05		5.0E-03	NA	2.0E-03	
Ethylbenzene	7.0E-06		2.9E-01	NA	2.5E-05	
Xylene (total)			NA	NA		
Total HQ & CR					**3.2E-02**	**1.2E-04**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

BASELINE

CALCULATION OF INTAKE (ONSITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		2.1E-06	1.58E+00	8	10	30	70	10,950	25,550
Chloroethane	4.1E-09		1.29E-03	8	10	30	70	10,950	25,550
Acetone			7.32E-02	8	10	30	70	10,950	25,550
Carbon Disulfide	4.5E-07		1.44E-01	8	10	30	70	10,950	25,550
1,1-Dichloroethene		3.3E-07	2.47E-01	8	10	30	70	10,950	25,550
1,2-Dichloroethene (total)	1.4E-04		4.33E+01	8	10	30	70	10,950	25,550
Chloroform		7.1E-09	5.26E-03	8	10	30	70	10,950	25,550
1,2-Dichloroethane	1.9E-07	8.2E-08	6.13E-02	8	10	30	70	10,950	25,550
2-Butanone	6.3E-09		2.01E-03	8	10	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	8	10	30	70	10,950	25,550
Trichloroethene		5.6E-05	4.20E+01	8	10	30	70	10,950	25,550
Benzene		2.4E-09	1.82E-03	8	10	30	70	10,950	25,550
Tetrachloroethene		2.5E-09	1.83E-03	8	10	30	70	10,950	25,550
Toluene	2.0E-07		6.30E-02	8	10	30	70	10,950	25,550
Chlorobenzene	1.2E-07		3.69E-02	8	10	30	70	10,950	25,550
Ethylbenzene	8.0E-08		2.57E-02	8	10	30	70	10,950	25,550
Xylene (total)			1.63E-01	8	10	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	8
EF = Exposure Frequency (days/yr)	10
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

09/12/94

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		2.1E-06	NA	2.9E-01		6.2E-07
Chloroethane	4.1E-09		2.9E+00	NA	1.4E-09	
Acetone			NA	NA		
Carbon Disulfide	4.5E-07		2.9E-03	NA	1.6E-04	
1,1-Dichloroethene		3.3E-07	NA	1.2E+00		4.0E-07
1,2-Dichloroethene (total)	1.4E-04		1.2E+00	NA	1.1E-04	
Chloroform		7.1E-09	NA	8.1E-02		5.7E-10
1,2-Dichloroethane	1.9E-07	8.2E-08	2.9E-03	9.1E-02	6.6E-05	7.5E-09
2-Butanone	6.3E-09		2.9E-01	NA	2.2E-08	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		5.6E-05	NA	6.0E-03		3.4E-07
Benzene		2.4E-09	NA	2.9E-02		7.1E-11
Tetrachloroethene		2.5E-09	NA	2.0E-03		4.9E-12
Toluene	2.0E-07		1.1E-01	NA	1.7E-06	
Chlorobenzene	1.2E-07		5.0E-03	NA	2.3E-05	
Ethylbenzene	8.0E-08		2.9E-01	NA	2.8E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**3.6E-04**	**1.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

09/12/94

BASELINE

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		6.6E-05	1.58E+00	20	150	25	70	9,125	25,550
Chloroethane	1.5E-07		1.29E-03	20	150	25	70	9,125	25,550
Acetone			7.32E-02	20	150	25	70	9,125	25,550
Carbon Disulfide	1.7E-05		1.44E-01	20	150	25	70	9,125	25,550
1,1-Dichloroethene		1.0E-05	2.47E-01	20	150	25	70	9,125	25,550
1,2-Dichloroethene (total)	5.1E-03		4.33E+01	20	150	25	70	9,125	25,550
Chloroform		2.2E-07	5.26E-03	20	150	25	70	9,125	25,550
1,2-Dichloroethane	7.2E-06	2.6E-06	6.13E-02	20	150	25	70	9,125	25,550
2-Butanone	2.4E-07		2.01E-03	20	150	25	70	9,125	25,550
1,1,1-Trichloroethane			0.00E+00	20	150	25	70	9,125	25,550
Trichloroethene		1.8E-03	4.20E+01	20	150	25	70	9,125	25,550
Benzene		7.6E-08	1.82E-03	20	150	25	70	9,125	25,550
Tetrachloroethene		7.7E-08	1.83E-03	20	150	25	70	9,125	25,550
Toluene	7.4E-06		6.30E-02	20	150	25	70	9,125	25,550
Chlorobenzene	4.3E-06		3.69E-02	20	150	25	70	9,125	25,550
Ethylbenzene	3.0E-06		2.57E-02	20	150	25	70	9,125	25,550
Xylene (total)			1.63E-01	20	150	25	70	9,125	25,550

EQUATION: Intake (mg/kg-day) =

$$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

BASELINE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		6.6E-05	NA	2.9E-01		1.9E-05
Chloroethane	1.5E-07		2.9E+00	NA	5.2E-08	
Acetone			NA	NA		
Carbon Disulfide	1.7E-05		2.9E-03	NA	5.9E-03	
1,1-Dichloroethene		1.0E-05	NA	1.2E+00		1.2E-05
1,2-Dichloroethene (total)	5.1E-03		1.2E+00	NA	4.2E-03	
Chloroform		2.2E-07	NA	8.1E-02		1.8E-08
1,2-Dichloroethane	7.2E-06	2.6E-06	2.9E-03	9.1E-02	2.5E-03	2.3E-07
2-Butanone	2.4E-07		2.9E-01	NA	8.2E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		1.8E-03	NA	6.0E-03		1.1E-05
Benzene		7.6E-08	NA	2.9E-02		2.2E-09
Tetrachloroethene		7.7E-08	NA	2.0E-03		1.5E-10
Toluene	7.4E-06		1.1E-01	NA	6.5E-05	
Chlorobenzene	4.3E-06		5.0E-03	NA	8.7E-04	
Ethylbenzene	3.0E-06		2.9E-01	NA	1.1E-05	
Xylene (total)			NA	NA		
Total HQ & CR					**1.4E-02**	**4.3E-05**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

Case 1

CASE 1
CALCULATION OF TOTAL NONCARCINOGENIC AND CARCINOGENIC RISKS

SENECA ARMY DEPOT
ASH LANDFILL

RECEPTOR	EXPOSURE ROUTE	HAZARD INDEX	CANCER RISK
CURRENT RESIDENTIAL			
CURRENT OFF-SITE RESIDENTS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	1.4E-01	5.6E-06
	Dermal Contact to Groundwater	3.2E-03	2.5E-07
	Inhalation of Groundwater while Showering	3.1E-07	1.1E-07
	Inhalation of Volatile Organics in Ambient Air	2.6E-04	3.2E-07
TOTAL RECEPTOR RISK (Nc & CAR)		1.5E-01	1.5E-05
CURRENT AND FUTURE ON SITE			
ON-SITE HUNTERS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Onsite Soils	9.5E-04	2.2E-07
	Dermal Contact to Onsite Soils	1.4E-03	4.4E-08
	Inhalation of Volatile Organics in Ambient Air	1.3E-05	1.6E-08
TOTAL RECEPTOR RISK (Nc & CAR)		7.5E-03	9.4E-06
FUTURE ON-SITE CONSTRUCTION WORKERS	Ingestion of Onsite Soils	9.2E-03	1.9E-06
	Dermal Contact to Onsite Soils	5.4E-02	1.4E-06
	Inhalation of Volatile Organics in Ambient Air	4.7E-04	4.9E-07
TOTAL RECEPTOR RISK (Nc & CAR)		6.4E-02	3.7E-06
TOTAL CURRENT AND INTENDED-FUTURE SITE USE RISKS		2.2E-01	2.9E-05
FUTURE RESIDENTIAL			
FUTURE ON-SITE RESIDENTS	Ingestion of Onsite Soils	3.4E-01	2.0E-05
	Dermal Contact to Onsite Soils	3.8E-01	4.6E-06
	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	3.2E+00	1.4E-03
	Dermal Contact to Groundwater	2.0E-01	7.1E-05
	Inhalation of Groundwater while Showering	1.0E-03	2.9E-05
	Inhalation of Volatile Organics in Ambient Air	1.1E-03	1.4E-06
TOTAL RECEPTOR RISK (Nc & CAR)		4.2E+00	1.5E-03
TOTAL SOIL RISK		7.9E-01	3.0E-05
TOTAL GROUNDWATER RISK		3.6E+00	1.5E-03
TOTAL SEDIMENT RISK		5.9E-03	0.0E+00
TOTAL SURFACE WATER RISK		6.2E-03	1.8E-05
CURRENT SOIL RISK		6.6E-02	4.3E-06
FUTURE SOIL RISK		7.3E-01	2.6E-05

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CASE 1

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN SURFACE SOIL ANALYSIS RESULTS VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration
Volatile Organics						
Vinyl Chloride	ug/kg	200	8	6.20	6.07	6.20
1,2-Dichloroethene (total)	ug/kg	300	7	4.43	4.01	4.43
Trichloroethene	ug/kg	700	130	16.64	14.43	16.64
Semi-volatiles						
2-Methylnaphthalene	ug/kg	36,400	1250	360.05	318.57	360.05
Acenaphthylene	ug/kg	41,000	510	251.08	209.08	251.08
Dibenzofuran	ug/kg	6,200	1400	407.83	352.36	407.83
Phenanthrene	ug/kg	50,000	15000	1,047.87	998.34	1,047.87
Benzo(a)anthracene	ug/kg	220 or MDL	9600	915.76	741.85	915.76
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	230000	987.69	4,749.60	987.69
Benzo(b)fluoranthene	ug/kg	1,100	9500	833.22	744.38	833.22
Benzo(k)fluoranthene	ug/kg	1,100	6700	711.51	595.21	711.51
Benzo(a)pyrene	ug/kg	61 or MDL	9000	876.03	702.87	876.03
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	4800	635.36	493.98	635.36
Dibenz(a,h)anthracene	ug/kg	14 or MDL	2000	466.15	385.94	466.15
Benzo(g,h,i)perylene	ug/kg	50,000	5000	680.92	506.77	680.92
Pesticides/PCB's						
Aroclor-1260	ug/kg	1,000	340	161.11	141.39	161.11
Metals						
Cadmium	mg/kg	1.74	43.1	5.53	3.22	5.53
Chromium	mg/kg	26.49	62	30.55	28.34	30.55
Copper	mg/kg	25	836	71.55	69.80	71.55
Lead	mg/kg	30	2890	264.93	208.08	264.93
Zinc	mg/kg	88.89	55700	1,579.68	2,111.63	1,579.68

CASE 1

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics						
Vinyl Chloride	ug/kg	200	17	6.14	5.94	6.14
1,2-Dichloroethene (total)	ug/kg	300	210	9.13	12.69	9.13
Trichloroethene	ug/kg	700	540	17.23	21.11	17.23
Semivolatiles						
2-Methylnaphthalene	ug/kg	36,400	3,600	441.35	393.12	441.35
Acenaphthylene	ug/kg	41,000	510	265.48	248.15	265.48
Dibenzofuran	ug/kg	6,200	7,000	397.55	373.26	397.55
Phenanthrene	ug/kg	50,000	43,000	657.71	882.10	657.71
Benzo(a)anthracene	ug/kg	220 or MDL	9,600	520.48	531.23	520.48
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	230,000	714.92	2,050.95	714.92
Benzo(b)fluoranthene	ug/kg	1,100	9,500	498.22	513.04	498.22
benzo(k)fluoranthene	ug/kg	1,100	6,700	468.90	447.89	468.90
Benzo(a)pyrene	ug/kg	61 or MDL	9,000	490.78	486.21	490.78
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	4,800	430.56	396.93	430.56
Dibenz(a,h)anthracene	ug/kg	14 or MDL	2,900	410.55	367.55	410.55
Benzo(g,h,i)perylene	ug/kg	50,000	5,000	431.19	392.32	431.19
Pesticides/PCBs						
Aroclor-1260	ug/kg	1,000	770	157.24	143.06	157.24
Metals						
Cadmium	mg/kg	1.74	43.1	3.84	2.47	3.84
Chromium	mg/kg	26.49	62	27.72	26.73	27.72
Copper	mg/kg	25	836	40.46	43.64	40.46
Lead	mg/kg	30	2,890	90.05	115.46	90.05
Zinc	mg/kg	88.89	55,700	409.06	860.14	409.06

CASE 1
CALCULATION OF INTAKE (ONSITE) FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																Child(Nc)	Adult(Nc)	Car
Volatile Organics																		
Vinyl Chloride	9.7E-09		6.8E-09		2.9E-09	6.20E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dichloroethene, 1,2- (total)		5.7E-08		6.1E-09		4.43E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trichloroethene	2.6E-08		1.8E-08		7.8E-09	1.66E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Semi-volatiles																		
Methylnaphthalene, 2-						3.60E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Acenaphthylene						2.51E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzofuran						4.08E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene						1.05E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.4E-06		1.0E-06		4.3E-07	9.16E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
bis(2-Ethylhexyl)phthalate	1.5E-06	1.3E-05	1.1E-06	1.4E-06	4.6E-07	9.88E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.3E-06		9.1E-07		3.9E-07	8.33E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.1E-06		7.8E-07		3.3E-07	7.12E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.4E-06		9.6E-07		4.1E-07	8.76E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	9.9E-07		7.0E-07		3.0E-07	6.35E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	7.3E-07		5.1E-07		2.2E-07	4.66E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene						6.81E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCB's																		
Aroclor-1260	2.5E-07		1.8E-07		7.6E-08	1.61E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																		
Cadmium		7.1E-05		7.6E-06		5.53E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium VI		3.9E-04		4.2E-05		3.06E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper		9.1E-04		9.8E-05		7.16E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead						2.65E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc		2.0E-02		2.2E-03		1.58E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)/ 200 (Child)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	350 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)/ 15 (Child 6-7)
AT = Averaging Time (days)	6 x 365 Child 24 x 365 Adult (NC) 70 x 365 (C)

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Vinyl Chloride			9.7E-09	NA	1.9E+00				1.8E-08
Dichloroethene, 1,2- (total)	6.07E-09	5.7E-08		9.0E-03	NA	6.7E-07	6.3E-06	7.0E-06	
Trichloroethene			2.6E-08	NA	1.1E-02				2.9E-10
Semi-volatiles									
Methylnaphthalene, 2-				NA	NA				
Acenaphthylene				NA	NA				
Dibenzofuran				NA	NA				
Phenanthrene				NA	NA				
Benzo(a)anthracene			1.4E-06	NA	7.3E-01				1.0E-06
bis(2-Ethylhexyl)phthalate	1.35E-06	1.3E-05	1.5E-06	2.0E-02	1.4E-02	6.8E-05	6.3E-04	7.0E-04	2.2E-08
Benzo(b)fluoranthene			1.3E-06	NA	7.3E-01				9.5E-07
Benzo(k)fluoranthene			1.1E-06	NA	7.3E-02				8.1E-08
Benzo(a)pyrene			1.4E-06	NA	7.3E+00				1.0E-05
Indeno(1,2,3-cd)pyrene			9.9E-07	NA	7.3E-01				7.3E-07
Dibenzo(a,h)anthracene			7.3E-07	NA	7.3E+00				5.3E-06
Benzo(g,h,i)perylene				NA	NA				
Pesticides/PCB's									
Aroclor-1260			2.5E-07	NA	7.7E+00				1.9E-06
Metals									
Cadmium	7.58E-06	7.1E-05		5.0E-04	NA	1.5E-02	1.4E-01	1.6E-01	
Chromium VI	4.19E-05	3.9E-04		5.0E-03	NA	8.4E-03	7.8E-02	8.6E-02	
Copper	9.80E-05	9.1E-04		4.0E-02	NA	2.5E-03	2.3E-02	2.5E-02	
Lead				NA	NA				
Zinc	2.16E-03	2.0E-02		3.0E-01	NA	7.2E-03	6.7E-02	7.5E-02	
Totals - HQ & CR								**3.4E-01**	**2.0E-05**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1
CALCULATION OF INTAKE (ONSITE) FROM INGESTION OF SOIL (DAILY) CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		1.3E-09	6.14E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Dichloroethene, 1,2- (total)	5.4E-09		9.13E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Trichloroethene		3.6E-09	1.72E-02	100	1.0E-06	1	150	25	70	9,125	25,550
Semi-volatiles											
Methylnaphthalene, 2-			4.41E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Acenaphthylene			2.65E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzofuran			3.98E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			6.58E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		1.1E-07	5.20E-01	100	1.0E-06	1	150	25	70	9,125	25,550
bis(2-Ethylhexyl)phthalate	4.2E-07	1.5E-07	7.15E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		1.0E-07	4.98E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		9.8E-08	4.69E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		1.0E-07	4.91E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		9.0E-08	4.31E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		8.6E-08	4.11E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			4.31E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Aroclor-1260		3.3E-08	1.57E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Cadmium	2.3E-06		3.84E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Chromium VI	1.6E-05		2.77E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Copper	2.4E-05		4.05E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Lead			9.00E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Zinc	2.4E-04		4.09E+02	100	1.0E-06	1	150	25	70	9,125	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	150 events/year
ED = Exposure Duration (years)	25 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

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CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**CDI (Nc)** (mg/kg-day)	**CDI (Car)** (mg/kg-day)	**RfD** (mg/kg-day)	**Oral Slope Factor** (mg/kg-day)-1	**Hazard Quotient**	**Cancer Risk**
Volatile Organics						
Vinyl Chloride		1.3E-09	NA	1.9E+00		2.4E-09
Dichloroethene, 1,2- (total)	5.4E-09		9.0E-03	NA	6.0E-07	
Trichloroethene		3.6E-09	NA	1.1E-02		4.0E-11
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		1.1E-07	NA	7.3E-01		8.0E-08
bis(2-Ethylhexyl)phthalate	4.2E-07	1.5E-07	2.0E-02	1.4E-02	2.1E-05	2.1E-09
Benzo(b)fluoranthene		1.0E-07	NA	7.3E-01		7.6E-08
Benzo(k)fluoranthene		9.8E-08	NA	7.3E-02		7.2E-09
Benzo(a)pyrene		1.0E-07	NA	7.3E+00		7.5E-07
Indeno(1,2,3-cd)pyrene		9.0E-08	NA	7.3E-01		6.6E-08
Dibenzo(a,h)anthracene		8.6E-08	NA	7.3E+00		6.3E-07
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		3.3E-08	NA	7.7E+00		2.5E-07
Metals						
Cadmium	2.3E-06		5.0E-04	NA	4.5E-03	
Chromium VI	1.6E-05		5.0E-03	NA	3.3E-03	
Copper	2.4E-05		4.0E-02	NA	5.9E-04	
Lead			NA	NA		
Zinc	2.4E-04		3.0E-01	NA	8.0E-04	
Totals - HQ & CR					**9.2E-03**	**1.9E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		1.0E-10	6.20E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Dichloroethene, 1,2- (total)	1.7E-10		4.43E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Trichloroethene		2.8E-10	1.66E-02	100	1.0E-06	1	10	30	70	10,950	25,550
Semi-volatiles											
Methylnaphthalene, 2-			3.60E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Acenaphthylene			2.51E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzofuran			4.08E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Phenanthrene			1.05E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)anthracene		1.5E-08	9.16E-01	100	1.0E-06	1	10	30	70	10,950	25,550
bis(2-Ethylhexyl)phthalate	3.9E-08	1.7E-08	9.88E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(b)fluoranthene		1.4E-08	8.33E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(k)fluoranthene		1.2E-08	7.12E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)pyrene		1.5E-08	8.76E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene		1.1E-08	6.35E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzo(a,h)anthracene		7.8E-09	4.66E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(g,h,i)perylene			6.81E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Pesticides/PCB's											
Aroclor-1260		2.7E-09	1.61E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Metals											
Cadmium	2.2E-07		5.53E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Chromium VI	1.2E-06		3.06E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Copper	2.8E-06		7.16E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Lead			2.65E+02	100	1.0E-06	1	10	30	70	10,950	25,550
Zinc	6.2E-05		1.58E+03	100	1.0E-06	1	10	30	70	10,950	25,550

Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	10 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

07/07/94

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.0E-10	NA	1.9E+00		2.0E-10
Dichloroethene, 1,2- (total)	1.7E-10		9.0E-03	NA	1.9E-08	
Trichloroethene		2.8E-10	NA	1.1E-02		3.1E-12
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		1.5E-08	NA	7.3E-01		1.1E-08
bis(2-Ethylhexyl)phthalate	3.9E-08	1.7E-08	2.0E-02	1.4E-02	1.9E-06	2.3E-10
Benzo(b)fluoranthene		1.4E-08	NA	7.3E-01		1.0E-08
Benzo(k)fluoranthene		1.2E-08	NA	7.3E-02		8.7E-10
Benzo(a)pyrene		1.5E-08	NA	7.3E+00		1.1E-07
Indeno(1,2,3-cd)pyrene		1.1E-08	NA	7.3E-01		7.8E-09
Dibenzo(a,h)anthracene		7.8E-09	NA	7.3E+00		5.7E-08
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		2.7E-09	NA	7.7E+00		2.1E-08
Metals						
Cadmium	2.2E-07		5.0E-04	NA	4.3E-04	
Chromium VI	1.2E-06		5.0E-03	NA	2.4E-04	
Copper	2.8E-06		4.0E-02	NA	7.0E-05	
Lead			NA	NA		
Zinc	6.2E-05		3.0E-01	NA	2.1E-04	
Totals - HQ & CR					**9.5E-04**	**2.2E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1
CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm^2)	Adherence Factor (mg soil/cm^2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		1.7E-07	1.61E-01	1.0E-06	5,000	1.0	0.1	150	25	70	9,125	25,550
Metals												
Cadmium	1.6E-06		5.53E+00	1.0E-06	5,000	1.0	0.01	150	25	70	9,125	25,550

EQUATION:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)	EF = Exposure Frequency (days/year)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm^2)	5000(A)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm^2)	1.00	AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)
ABS = Absorption Factor (unitless)	varies EPA, 1992		

08/16/94

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**CDI (Nc)** (mg/kg-day)	**CDI (Car)** (mg/kg-day)	**Dermal RfD** (mg/kg-day)	**Dermal Slope Factor** (mg/kg-day)-1	**Hazard Quotient**	**Cancer Risk**
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		1.7E-07	NA	8.1E+00		1.4E-06
Metals						
Cadmium	1.6E-06		3.0E-05	NA	5.4E-02	
Totals - HQ & CR					**5.4E-02**	**1.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1
CALCULATION OF ABSORBED DOSE (ONSITE) FROM DERMAL CONTACT TO SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		5.4E-09	1.61E-01	1.0E-06	2,000	1.0	0.1	10	30	70	10,950	25,550
Metals												
Cadmium	4.3E-08		5.53E+00	1.0E-06	2,000	1.0	0.01	10	30	70	10,950	25,550

EQUATION:

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	10 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm²)	2000 cm² (Adult)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1	AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 Adult (Car)
ABS = Absorption Factor (unitless)	0.01		

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		5.4E-09	NA	8.1E+00		4.4E-08
Metals						
Cadmium	4.3E-08		3.0E-05	NA	1.4E-03	
Totals - HQ & CR					**1.4E-03**	**4.4E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

08/15/94

CASE 1

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm²)	Adult Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Volatile Organics																			
Semi-volatiles																			
Pesticides/PCB's																			
Aroclor-1260	5.7E-07		1.9E-07		3.8E-07	1.61E-01	1.0E-06	2,165	5,000	1.0	0.1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Cadmium	0.0E+00	7.7E-06		3.8E-06		5.53E+00	1.0E-06	2,165	5,000	1.0	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**	**Variables:**	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm²)	2165(C)/5000(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1.00	AT = Averaging Time (days)	6 x 365 Child 24 x 365 Adult (Nc)
ABS = Absorption Factor (unitless)	varies EPA, 1992		70 x 365 (Car)

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
<u>Volatile Organics</u>									
<u>Semi-volatiles</u>									
<u>Pesticides/PCB's</u>									
Aroclor-1260			5.7E-07	NA	8.1E+00				4.6E-06
<u>Metals</u>									
Cadmium	3.8E-06	7.7E-06	0.0E+00	3.0E-05	NA	1.3E-01	2.6E-01	3.8E-01	
Totals - HQ & CR								**3.8E-01**	**4.6E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1

CALCULATION OF VOLATILE ORGANIC COMPOUNDS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT ASH LANDFILL

COMPOUND	**Off-Site Conc.** ug/m³	**On-Site Conc.** ug/m³	**Average Emission Rate Ei** g/s	**Effective Diffusivity Dei** cm²/s	**Molecular Diffusivity Di** cm²/s	**Bulk Soil Concentration Ci** g/g	**Exposure Interval t** sec.	**Soil Porosity ε**	**Exposed Surface Area A** cm²	**Constant a**	**Soil/Air Partition Coef. Kas** g/cm³
Volatile Organics											
Vinyl Chloride	0.006	0.025	8.7471E-06	0.074023	0.102103	7.1938E-09	9.10E+08	0.38	6.82E+07	2.98E-02	2.95
Chloroethane	NA	NA	NA	0.0718	0.099037	ERR	9.10E+08	0.38	6.82E+07	1.20E-03	0.07
Acetone	0.001	0.002	8.2995E-07	0.071065	0.098023	1.1139E-08	9.10E+08	0.38	6.82E+07	3.11E-04	0.02
Carbon Disulfide	0.002	0.007	2.3233E-06	0.076044	0.10489	5.8223E-09	9.10E+08	0.38	6.82E+07	7.34E-03	0.47
1,1-Dichloroethene	0.004	0.017	5.7693E-06	0.062898	0.086758	9.8902E-09	9.10E+08	0.38	6.82E+07	1.24E-02	1.07
1,2-Dichloroethene (total)	0.015	0.063	2.1497E-05	0.062898	0.086758	8.6957E-08	9.10E+08	0.38	6.82E+07	3.12E-03	0.23
Chloroform	0.001	0.003	1.1026E-06	0.068672	0.094722	5.8223E-09	9.10E+08	0.38	6.82E+07	1.91E-03	0.13
1,2-Dichloroethane	0.001	0.004	1.3178E-06	0.061481	0.084803	6.8658E-09	9.10E+08	0.38	6.82E+07	1.95E-03	0.14
2-Butanone	0.000	0.001	4.5030E-07	0.061749	0.085173	8.0465E-09	9.10E+08	0.38	6.82E+07	1.76E-04	0.01
1,1,1-Trichloroethane	0.000	0.000	0.0000E+00	0.055018	0.075889	0.0000E+00	9.10E+08	0.38	6.82E+07	2.34E-03	0.19
Trichloroethene	0.019	0.081	2.7672E-05	0.056046	0.077306	1.4843E-07	9.10E+08	0.38	6.82E+07	1.84E-03	0.15
Benzene	0.000	0.002	5.6007E-07	0.06013	0.08294	3.0067E-09	9.10E+08	0.38	6.82E+07	1.84E-03	0.14
Tetrachloroethene	0.000	0.002	5.3164E-07	0.051194	0.070614	3.0067E-09	9.10E+08	0.38	6.82E+07	1.65E-03	0.15
Toluene	0.000	0.002	5.7657E-07	0.054111	0.074637	5.8730E-09	9.10E+08	0.38	6.82E+07	5.33E-04	0.04
Chlorobenzene	0.000	0.001	4.1326E-07	0.053528	0.073833	5.8223E-09	9.10E+08	0.38	6.82E+07	2.81E-04	0.02
Ethylbenzene	0.000	0.001	2.8600E-07	0.049563	0.068364	5.8223E-09	9.10E+08	0.38	6.82E+07	1.35E-04	0.01
Xylene (total)	0.000	0.002	6.4417E-07	0.049563	0.068364	5.8223E-09	9.10E+08	0.38	6.82E+07	6.72E-04	0.06

07/06/94

CASE 1

CALCULATION OF INTAKE (OFF-SITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**Intake (Nc)** (mg/kg-day)	**Intake (Car)** (mg/kg-day)	**95th UCL Air** (ug/m³)	**Inhalation Rate** (m³/day)	**Exposure Frequency** (days/year)	**Exposure Duration** (years)	**Body Weight** (kg)	**Averaging Time** (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		7.1E-07	6.04E-03	20	350	30	70	10,950	25,550
Chloroethane			NA	20	350	30	70	10,950	25,550
Acetone			5.74E-04	20	350	30	70	10,950	25,550
Carbon Disulfide	4.4E-07		1.61E-03	20	350	30	70	10,950	25,550
1,1-Dichloroethene		4.7E-07	3.99E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	4.1E-06		1.49E-02	20	350	30	70	10,950	25,550
Chloroform		8.9E-08	7.62E-04	20	350	30	70	10,950	25,550
1,2-Dichloroethane	2.5E-07	1.1E-07	9.11E-04	20	350	30	70	10,950	25,550
2-Butanone	8.5E-08		3.11E-04	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		2.2E-06	1.91E-02	20	350	30	70	10,950	25,550
Benzene		4.5E-08	3.87E-04	20	350	30	70	10,950	25,550
Tetrachloroethene		4.3E-08	3.67E-04	20	350	30	70	10,950	25,550
Toluene	1.1E-07		3.98E-04	20	350	30	70	10,950	25,550
Chlorobenzene	7.8E-08		2.86E-04	20	350	30	70	10,950	25,550
Ethylbenzene	5.4E-08		1.98E-04	20	350	30	70	10,950	25,550
Xylene (total)			4.45E-04	20	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

07/06/94

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		7.1E-07	NA	2.9E-01		2.1E-07
Chloroethane			2.9E+00	NA		
Acetone			NA	NA		
Carbon Disulfide	4.4E-07		2.9E-03	NA	1.5E-04	
1,1-Dichloroethene		4.7E-07	NA	1.8E-01		8.2E-08
1,2-Dichloroethene (total)	4.1E-06		1.2E+00	NA	3.4E-06	
Chloroform		8.9E-08	NA	8.1E-02		7.2E-09
1,2-Dichloroethane	2.5E-07	1.1E-07	2.9E-03	9.1E-02	8.6E-05	9.7E-09
2-Butanone	8.5E-08		2.9E-01	NA	3.0E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		2.2E-06	NA	6.0E-03		1.3E-08
Benzene		4.5E-08	NA	2.9E-02		1.3E-09
Tetrachloroethene		4.3E-08	NA	2.0E-03		8.6E-11
Toluene	1.1E-07		1.1E-01	NA	9.6E-07	
Chlorobenzene	7.8E-08		5.0E-03	NA	1.6E-05	
Ethylbenzene	5.4E-08		2.9E-01	NA	1.9E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**2.6E-04**	**3.2E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

Case 2

CASE 2
CALCULATION OF TOTAL NONCARCINOGENIC AND CARCINOGENIC RISKS

SENECA ARMY DEPOT
ASH LANDFILL

RECEPTOR	EXPOSURE ROUTE	HAZARD INDEX	CANCER RISK
CURRENT RESIDENTIAL			
CURRENT OFF-SITE RESIDENTS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	1.4E-01	5.6E-06
	Dermal Contact to Groundwater	3.2E-03	2.5E-07
	Inhalation of Groundwater while Showering	3.1E-07	1.1E-07
	Inhalation of Volatile Organics in Ambient Air	2.6E-04	3.2E-07
TOTAL RECEPTOR RISK (Nc & CAR)		1.5E-01	1.5E-05
CURRENT AND FUTURE ON SITE			
ON-SITE HUNTERS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Onsite Soils	1.3E-03	3.0E-07
	Dermal Contact to Onsite Soils	2.1E-03	4.6E-08
	Inhalation of Volatile Organics in Ambient Air	1.3E-05	1.6E-08
TOTAL RECEPTOR RISK (Nc & CAR)		8.5E-03	9.5E-06
FUTURE ON-SITE CONSTRUCTION WORKERS	Ingestion of Onsite Soils	1.0E-02	2.2E-06
	Dermal Contact to Onsite Soils	7.8E-02	1.5E-06
	Inhalation of Volatile Organics in Ambient Air	4.7E-04	4.9E-07
TOTAL RECEPTOR RISK (Nc & CAR)		8.9E-02	4.1E-06
TOTAL CURRENT AND INTENDED-FUTURE SITE USE RISKS		2.5E-01	2.9E-05
FUTURE RESIDENTIAL			
FUTURE ON-SITE RESIDENTS	Ingestion of Onsite Soils	4.7E-01	2.8E-05
	Dermal Contact to Onsite Soils	5.5E-01	4.9E-06
	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	3.2E+00	1.4E-03
	Dermal Contact to Groundwater	2.0E-01	7.1E-05
	Inhalation of Groundwater while Showering	1.0E-03	2.9E-05
	Inhalation of Volatile Organics in Ambient Air	1.1E-03	1.4E-06
TOTAL RECEPTOR RISK (Nc & CAR)		4.5E+00	1.6E-03
TOTAL SOIL RISK		1.1E+00	3.9E-05
TOTAL GROUNDWATER RISK		3.6E+00	1.5E-03
TOTAL SEDIMENT RISK		5.9E-03	0.0E+00
TOTAL SURFACE WATER RISK		6.2E-03	1.8E-05
CURRENT SOIL RISK		9.3E-02	4.8E-06
FUTURE SOIL RISK		1.0E+00	3.4E-05

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CASE 2

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SURFACE SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	COUNT	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration	STD.DEV
Volatile Organics								
Vinyl Chloride	ug/kg	200	32	8	6.21	6.08	6.21	0.46
1,2-Dichloroethene (total)	ug/kg	300	32	7	4.28	3.88	4.28	1.39
Trichloroethene	ug/kg	700	32	130	12.57	12.00	12.57	27.33
Semi-volatiles								
2-Methylnaphthalene	ug/kg	36,400	33	1250	410.66	351.55	410.66	206.43
Acenaphthylene	ug/kg	41,000	14	510	273.43	210.07	273.43	144.12
Dibenzofuran	ug/kg	6,200	33	1400	476.15	393.42	476.15	288.91
Phenanthrene	ug/kg	50,000	33	15000	1,759.63	1,285.48	1,759.63	3,358.91
Benzo(a)anthracene	ug/kg	220 or MDL	33	9600	1,498.27	946.15	1,498.27	2,195.76
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	33	230000	1,937.29	7,438.73	1,937.29	39,955.45
Benzo(b)fluoranthene	ug/kg	1,100	33	9500	1,253.02	946.88	1,253.02	2,165.51
Benzo(k)fluoranthene	ug/kg	1,100	33	6700	1,058.53	759.06	1,058.53	1,509.75
Benzo(a)pyrene	ug/kg	61 or MDL	33	9000	1,321.13	916.06	1,321.13	2,049.73
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	33	4800	918.01	610.39	918.01	1,078.36
Dibenz(a,h)anthracene	ug/kg	14 or MDL	33	2000	572.47	451.00	572.47	424.19
Benzo(g,h,i)perylene	ug/kg	50,000	33	5000	922.86	643.00	922.86	1,042.14
Pesticides/PCB's								
Aroclor-1260	ug/kg	1,000	33	330	170.72	146.61	170.72	84.23
Metals								
Cadmium	mg/kg	1.74	33	43.1	8.02	3.93	8.02	7.42
Chromium	mg/kg	26.49	33	62	34.42	31.34	34.42	10.77
Copper	mg/kg	25	33	836	98.86	85.28	98.86	165.80
Lead	mg/kg	30	28	2890	748.73	306.85	748.73	692.15
Zinc	mg/kg	88.89	33	55700	2,328.63	2,807.77	2,328.63	10,630.66

CASE 2

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics						
Vinyl Chloride	ug/kg	200	17	6.10	5.91	6.10
1,2-Dichloroethene (total)	ug/kg	300	210	6.42	8.44	6.42
Trichloroethene	ug/kg	700	540	12.69	18.20	12.69
Semivolatiles						
2-Methylnaphthalene	ug/kg	36,400	2,700	439.47	380.34	439.47
Acenaphthylene	ug/kg	41,000	510	288.81	265.61	288.81
Dibenzofuran	ug/kg	6,200	7,000	433.90	410.77	433.90
Phenanthrene	ug/kg	50,000	43,000	865.75	1,159.94	865.75
Benzo(a)anthracene	ug/kg	220 or MDL	9,600	663.69	644.49	663.69
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	230,000	974.43	3,072.97	974.43
Benzo(b)fluoranthene	ug/kg	1,100	9,500	612.12	615.98	612.12
benzo(k)fluoranthene	ug/kg	1,100	6,700	558.82	529.99	558.82
Benzo(a)pyrene	ug/kg	61 or MDL	9,000	601.91	584.63	601.91
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	4,800	500.71	450.37	500.71
Dibenz(a,h)anthracene	ug/kg	14 or MDL	2,900	462.30	401.78	462.30
Benzo(g,h,i)perylene	ug/kg	50,000	5,000	484.75	451.18	484.75
Pesticides/PCBs						
Aroclor-1260	ug/kg	1,000	430	152.33	138.41	152.33
Metals						
Cadmium	mg/kg	1.74	43.1	4.46	2.87	4.46
Chromium	mg/kg	26.49	62	29.44	28.02	29.44
Copper	mg/kg	25	836	46.67	50.80	46.67
Lead	mg/kg	30	2,890	139.78	160.80	139.78
Zinc	mg/kg	88.89	55,700	423.13	1,093.71	423.13

CASE 2
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																Child(Nc)	Adult(Nc)	Car
Volatile Organics																		
Vinyl Chloride	9.7E-09		6.8E-09		2.9E-09	6.21E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dichloroethene, 1,2- (total)		5.5E-08		5.9E-09		4.28E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trichloroethene	2.0E-08		1.4E-08		5.9E-09	1.26E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Semi-volatiles																		
Methylnaphthalene, 2-						4.11E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Acenaphthylene						2.73E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzofuran						4.76E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene						1.76E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	2.3E-06		1.6E-06		7.0E-07	1.50E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
bis(2-Ethylhexyl)phthalate	3.0E-06	2.5E-05	2.1E-06	2.7E-06	9.1E-07	1.94E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	2.0E-06		1.4E-06		5.9E-07	1.25E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.7E-06		1.2E-06		5.0E-07	1.06E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	2.1E-06		1.4E-06		6.2E-07	1.32E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.4E-06		1.0E-06		4.3E-07	9.18E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	9.0E-07		6.3E-07		2.7E-07	5.72E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene						9.23E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCB's																		
Aroclor-1260	2.7E-07		1.9E-07		8.0E-08	1.71E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																		
Cadmium		1.0E-04		1.1E-05		8.02E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium VI		4.4E-04		4.7E-05		3.44E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper		1.3E-03		1.4E-04		9.89E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead						7.49E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc		3.0E-02		3.2E-03		2.33E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	**95th UCL Soil Data**
IR = Ingestion Rate (mg soil/day)	**100 (Adult)/ 200 (Child)**
CF = Conversion Factor (10-6 kg/mg)	**10-6**
FI = Fraction Ingested (unitless)	**1**
EF = Exposure Frequency (days/years)	**350 events/year**
ED = Exposure Duration (years)	**30 years**
BW = Bodyweight (kg)	**70 (Adult male)/ 15 (Child 6-7)**
AT = Averaging Time (days)	**6 x 365 Child 24 x 365 Adult (NC)** **70 x 365 (C)**

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Vinyl Chloride			9.7E-09	NA	1.9E+00				1.8E-08
Dichloroethene, 1,2- (total)	5.86E-09	5.5E-08		9.0E-03	NA	6.5E-07	6.1E-06	6.7E-06	
Trichloroethene			2.0E-08	NA	1.1E-02				2.2E-10
Semi-volatiles									
Methylnaphthalene, 2-				NA	NA				
Acenaphthylene				NA	NA				
Dibenzofuran				NA	NA				
Phenanthrene				NA	NA				
Benzo(a)anthracene			2.3E-06	NA	7.3E-01				1.7E-06
bis(2-Ethylhexyl)phthalate	2.65E-06	2.5E-05	3.0E-06	2.0E-02	1.4E-02	1.3E-04	1.2E-03	1.4E-03	4.2E-08
Benzo(b)fluoranthene			2.0E-06	NA	7.3E-01				1.4E-06
Benzo(k)fluoranthene			1.7E-06	NA	7.3E-02				1.2E-07
Benzo(a)pyrene			2.1E-06	NA	7.3E+00				1.5E-05
Indeno(1,2,3-cd)pyrene			1.4E-06	NA	7.3E-01				1.0E-06
Dibenzo(a,h)anthracene			9.0E-07	NA	7.3E+00				6.5E-06
Benzo(g,h,i)perylene				NA	NA				
Pesticides/PCB's									
Aroclor-1260			2.7E-07	NA	7.7E+00				2.1E-06
Metals									
Cadmium	1.10E-05	1.0E-04		5.0E-04	NA	2.2E-02	2.0E-01	2.3E-01	
Chromium VI	4.72E-05	4.4E-04		5.0E-03	NA	9.4E-03	8.8E-02	9.7E-02	
Copper	1.35E-04	1.3E-03		4.0E-02	NA	3.4E-03	3.2E-02	3.5E-02	
Lead				NA	NA				
Zinc	3.19E-03	3.0E-02		3.0E-01	NA	1.1E-02	9.9E-02	1.1E-01	
Totals - HQ & CR								**4.7E-01**	**2.8E-05**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		1.3E-09	6.10E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Dichloroethene, 1,2- (total)	3.8E-09		6.42E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Trichloroethene		2.7E-09	1.27E-02	100	1.0E-06	1	150	25	70	9,125	25,550
Semi-volatiles											
Methylnaphthalene, 2-			4.39E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Acenaphthylene			2.89E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzofuran			4.34E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			8.66E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		1.4E-07	6.64E-01	100	1.0E-06	1	150	25	70	9,125	25,550
bis(2-Ethylhexyl)phthalate	5.7E-07	2.0E-07	9.74E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		1.3E-07	6.12E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		1.2E-07	5.59E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		1.3E-07	6.02E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		1.0E-07	5.01E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		9.7E-08	4.62E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			4.85E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Aroclor-1260		3.2E-08	1.52E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Cadmium	2.6E-06		4.46E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Chromium VI	1.7E-05		2.94E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Copper	2.7E-05		4.67E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Lead			1.40E+02	100	1.0E-06	1	150	25	70	9,125	25,550
Zinc	2.5E-04		4.23E+02	100	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	150 events/year
ED = Exposure Duration (years)	25 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

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CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (DAILY) CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE) SENECA ARMY DEPOT ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.3E-09	NA	1.9E+00		2.4E-09
Dichloroethene, 1,2- (total)	3.8E-09		9.0E-03	NA	4.2E-07	
Trichloroethene		2.7E-09	NA	1.1E-02		2.9E-11
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		1.4E-07	NA	7.3E-01		1.0E-07
bis(2-Ethylhexyl)phthalate	5.7E-07	2.0E-07	2.0E-02	1.4E-02	2.9E-05	2.9E-09
Benzo(b)fluoranthene		1.3E-07	NA	7.3E-01		9.4E-08
Benzo(k)fluoranthene		1.2E-07	NA	7.3E-02		8.6E-09
Benzo(a)pyrene		1.3E-07	NA	7.3E+00		9.2E-07
Indeno(1,2,3-cd)pyrene		1.0E-07	NA	7.3E-01		7.7E-08
Dibenzo(a,h)anthracene		9.7E-08	NA	7.3E+00		7.1E-07
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		3.2E-08	NA	7.7E+00		2.5E-07
Metals						
Cadmium	2.6E-06		5.0E-04	NA	5.2E-03	
Chromium VI	1.7E-05		5.0E-03	NA	3.5E-03	
Copper	2.7E-05		4.0E-02	NA	6.8E-04	
Lead			NA	NA		
Zinc	2.5E-04		3.0E-01	NA	8.3E-04	
Totals - HQ & CR					**1.0E-02**	**2.2E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		1.0E-10	6.21E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Dichloroethene, 1,2- (total)	1.7E-10		4.28E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Trichloroethene		2.1E-10	1.26E-02	100	1.0E-06	1	10	30	70	10,950	25,550
Semi-volatiles											
Methylnaphthalene, 2-			4.11E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Acenaphthylene			2.73E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzofuran			4.76E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Phenanthrene			1.76E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)anthracene		2.5E-08	1.50E+00	100	1.0E-06	1	10	30	70	10,950	25,550
bis(2-Ethylhexyl)phthalate	7.6E-08	3.2E-08	1.94E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(b)fluoranthene		2.1E-08	1.25E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(k)fluoranthene		1.8E-08	1.06E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)pyrene		2.2E-08	1.32E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene		1.5E-08	9.18E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzo(a,h)anthracene		9.6E-09	5.72E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(g,h,i)perylene			9.23E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Pesticides/PCB's											
Aroclor-1260		2.9E-09	1.71E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Metals											
Cadmium	3.1E-07		8.02E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Chromium VI	1.3E-06		3.44E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Copper	3.9E-06		9.89E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Lead			7.49E+02	100	1.0E-06	1	10	30	70	10,950	25,550
Zinc	9.1E-05		2.33E+03	100	1.0E-06	1	10	30	70	10,950	25,550

Intake (mg/kg-day) =

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	10 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (DAILY) HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE) SENECA ARMY DEPOT ASH LANDFILL

Analyte	**CDI (Nc)** (mg/kg-day)	**CDI (Car)** (mg/kg-day)	**RfD** (mg/kg-day)	**Oral Slope Factor** (mg/kg-day)-1	**Hazard Quotient**	**Cancer Risk**
Volatile Organics						
Vinyl Chloride		1.0E-10	NA	1.9E+00		2.0E-10
Dichloroethene, 1,2- (total)	1.7E-10		9.0E-03	NA	1.9E-08	
Trichloroethene		2.1E-10	NA	1.1E-02		2.3E-12
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		2.5E-08	NA	7.3E-01		1.8E-08
bis(2-Ethylhexyl)phthalate	7.6E-08	3.2E-08	2.0E-02	1.4E-02	3.8E-06	4.5E-10
Benzo(b)fluoranthene		2.1E-08	NA	7.3E-01		1.5E-08
Benzo(k)fluoranthene		1.8E-08	NA	7.3E-02		1.3E-09
Benzo(a)pyrene		2.2E-08	NA	7.3E+00		1.6E-07
Indeno(1,2,3-cd)pyrene		1.5E-08	NA	7.3E-01		1.1E-08
Dibenzo(a,h)anthracene		9.6E-09	NA	7.3E+00		7.0E-08
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		2.9E-09	NA	7.7E+00		2.2E-08
Metals						
Cadmium	3.1E-07		5.0E-04	NA	6.3E-04	
Chromium VI	1.3E-06		5.0E-03	NA	2.7E-04	
Copper	3.9E-06		4.0E-02	NA	9.7E-05	
Lead			NA	NA		
Zinc	9.1E-05		3.0E-01	NA	3.0E-04	
Totals - HQ & CR					**1.3E-03**	**3.0E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2
SENECA ARMY DEPOT
ASH LANDFILL-HOT SPOT
SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)
POTENTIAL CHEMICALS OF CONCERN

COMPOUND	units	NYSDEC TAGM	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD.DEV	COEF OF VARIATION	NORMAL/ LOGNORMAL
Volatile Organics									
Vinyl Chloride	ug/kg		27	17	7.19	6.44	2.37	0.37	NORMAL
Chloroethane	ug/kg		0	NA	NA	NA	0.00	NA	NA
Acetone	ug/kg		27	140	11.14	11.46	25.73	2.24	LOGNORMAL
Carbon Disulfide	ug/kg		27	9	5.82	5.35	1.49	0.28	NORMAL
1,1-Dichloroethene	ug/kg		27	140	9.89	10.19	25.99	2.55	LOGNORMAL
1,2-Dichloroethene (total)	ug/kg		27	210	86.96	39.28	69.87	1.78	LOGNORMAL
Chloroform	ug/kg		27	9	5.82	5.35	1.49	0.28	NORMAL
1,2-Dichloroethane	ug/kg		27	21	6.87	5.81	3.32	0.57	NORMAL
2-Butanone	ug/kg		27	22	8.05	6.89	3.66	0.53	NORMAL
1,1,1-Trichloroethane	ug/kg		0	NA	NA	NA	0.00	NA	NA
Trichloroethene	ug/kg		27	540	148.43	57.09	108.72	1.90	LOGNORMAL
Benzene	ug/kg		6	3	3.01	2.83	0.26	0.09	NORMAL
Tetrachloroethene	ug/kg		6	3	3.01	2.83	0.26	0.09	NORMAL
Toluene	ug/kg		27	9	5.87	5.43	1.41	0.26	NORMAL
Chlorobenzene	ug/kg		27	9	5.82	5.35	1.49	0.28	NORMAL
Ethylbenzene	ug/kg		27	9	5.82	5.35	1.49	0.28	NORMAL
Xylene (total)	ug/kg		27	9	5.82	5.35	1.49	0.28	NORMAL

CASE 2
CALCULATION OF ABSORBED DOSE (ONSITE) FROM DERMAL CONTACT TO SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm^2)	Adherence Factor (mg soil/cm^2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
<u>Volatile Organics</u>												
<u>Semi-volatiles</u>												
<u>Pesticides/PCB's</u>												
Aroclor-1260		5.7E-09	1.71E-01	1.0E-06	2,000	1.0	0.1	10	30	70	10,950	25,550
<u>Metals</u>												
Cadmium	6.3E-08		8.02E+00	1.0E-06	2,000	1.0	0.01	10	30	70	10,950	25,550

EQUATION: $$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

<u>Variables:</u>	<u>Assumptions:</u>	<u>Variables:</u>	<u>Assumptions:</u>
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	10 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm^2)	2000 cm^2 (Adult)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm^2)	1	AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 Adult (Car)
ABS = Absorption Factor (unitless)	0.01		

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE) SENECA ARMY DEPOT ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		5.7E-09	NA	8.1E+00		4.6E-08
Metals						
Cadmium	6.3E-08		3.0E-05	NA	2.1E-03	
Totals - HQ & CR					**2.1E-03**	**4.6E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2
CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm^2)	Adherence Factor (mg soil/cm^2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
<u>Volatile Organics</u>												
<u>Semi-volatiles</u>												
<u>Pesticides/PCB's</u>												
Aroclor-1260		1.8E-07	1.71E-01	1.0E-06	5,000	1.0	0.1	150	25	70	9,125	25,550
<u>Metals</u>												
Cadmium	2.4E-06		8.02E+00	1.0E-06	5,000	1.0	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) =

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

<u>Variables:</u>	<u>Assumptions:</u>	<u>Variables:</u>	<u>Assumptions:</u>
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)	EF = Exposure Frequency (days/year)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm^2)	5000(A)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm^2)	1.00	AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)
ABS = Absorption Factor (unitless)	varies EPA, 1992		

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		1.8E-07	NA	8.1E+00		1.5E-06
Metals						
Cadmium	2.4E-06		3.0E-05	NA	7.8E-02	
Totals - HQ & CR					**7.8E-02**	**1.5E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm^2)	Adult Skin Surface Area Contact (cm^2)	Adherence Factor (mg soil/cm^2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Volatile Organics																			
Semi-volatiles																			
Pesticides/PCB's																			
Aroclor-1260	6.0E-07		2.0E-07		4.0E-07	1.71E-01	1.0E-06	2,165	5,000	1.0	0.1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Cadmium	0.0E+00	1.1E-05		5.5E-06		8.02E+00	1.0E-06	2,165	5,000	1.0	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) =

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm^2)	2165(C)/5000(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm^2)	1.00	AT = Averaging Time (days)	6 x 365 Child 24 x 365 Adult (Nc)
ABS = Absorption Factor (unitless)	varies EPA, 1992		70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Semi-volatiles									
Pesticides/PCB's									
Aroclor-1260			6.0E-07	NA	8.1E+00				4.9E-06
Metals									
Cadmium	5.5E-06	1.1E-05	0.0E+00	3.0E-05	NA	1.8E-01	3.7E-01	5.5E-01	
Totals - HQ & CR								**5.5E-01**	**4.9E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2

CALCULATION OF VOLATILE ORGANIC COMPOUNDS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	Off-Site Conc. ug/m^3	On-Site Conc. ug/m^3	Average Emission Rate Ei g/s	Effective Diffusivity Dei cm^2/s	Molecular Diffusivity Di cm^2/s	Bulk Soil Concentration Ci g/g	Exposure Interval t sec.	Soil Porosity ε	Exposed Surface Area A cm^2	Constant a	Soil/Air Partition Coef. Kas g/cm^3
Volatile Organics											
Vinyl Chloride	0.006	0.025	8.7471E-06	0.074023	0.102103	7.1938E-09	9.10E+08	0.38	6.82E+07	2.98E-02	2.95
Chloroethane	NA	NA	NA	0.0718	0.099037	0.0000E+00	9.10E+08	0.38	6.82E+07	1.20E-03	0.07
Acetone	0.001	0.002	8.2995E-07	0.071065	0.098023	1.1139E-08	9.10E+08	0.38	6.82E+07	3.11E-04	0.02
Carbon Disulfide	0.002	0.007	2.3233E-06	0.076044	0.10489	5.8223E-09	9.10E+08	0.38	6.82E+07	7.34E-03	0.47
1,1-Dichloroethene	0.004	0.017	5.7693E-06	0.062898	0.086758	9.8902E-09	9.10E+08	0.38	6.82E+07	1.24E-02	1.07
1,2-Dichloroethene (total)	0.015	0.063	2.1497E-05	0.062898	0.086758	8.6957E-08	9.10E+08	0.38	6.82E+07	3.12E-03	0.23
Chloroform	0.001	0.003	1.1026E-06	0.068672	0.094722	5.8223E-09	9.10E+08	0.38	6.82E+07	1.91E-03	0.13
1,2-Dichloroethane	0.001	0.004	1.3178E-06	0.061481	0.084803	6.8658E-09	9.10E+08	0.38	6.82E+07	1.95E-03	0.14
2-Butanone	0.000	0.001	4.5030E-07	0.061749	0.085173	8.0465E-09	9.10E+08	0.38	6.82E+07	1.76E-04	0.01
1,1,1-Trichloroethane	0.000	0.000	0.0000E+00	0.055018	0.075889	0.0000E+00	9.10E+08	0.38	6.82E+07	2.34E-03	0.19
Trichloroethene	0.019	0.081	2.7672E-05	0.056046	0.077306	1.4843E-07	9.10E+08	0.38	6.82E+07	1.84E-03	0.15
Benzene	0.000	0.002	5.6007E-07	0.06013	0.08294	3.0067E-09	9.10E+08	0.38	6.82E+07	1.84E-03	0.14
Tetrachloroethene	0.000	0.002	5.3164E-07	0.051194	0.070614	3.0067E-09	9.10E+08	0.38	6.82E+07	1.65E-03	0.15
Toluene	0.000	0.002	5.7657E-07	0.054111	0.074637	5.8730E-09	9.10E+08	0.38	6.82E+07	5.33E-04	0.04
Chlorobenzene	0.000	0.001	4.1326E-07	0.053528	0.073833	5.8223E-09	9.10E+08	0.38	6.82E+07	2.81E-04	0.02
Ethylbenzene	0.000	0.001	2.8600E-07	0.049563	0.068364	5.8223E-09	9.10E+08	0.38	6.82E+07	1.35E-04	0.01
Xylene (total)	0.000	0.002	6.4417E-07	0.049563	0.068364	5.8223E-09	9.10E+08	0.38	6.82E+07	6.72E-04	0.06

CASE 2

CALCULATION OF INTAKE (OFF-SITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		7.1E-07	6.04E-03	20	350	30	70	10,950	25,550
Chloroethane			NA	20	350	30	70	10,950	25,550
Acetone			5.74E-04	20	350	30	70	10,950	25,550
Carbon Disulfide	4.4E-07		1.61E-03	20	350	30	70	10,950	25,550
1,1-Dichloroethene		4.7E-07	3.99E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	4.1E-06		1.49E-02	20	350	30	70	10,950	25,550
Chloroform		8.9E-08	7.62E-04	20	350	30	70	10,950	25,550
1,2-Dichloroethane	2.5E-07	1.1E-07	9.11E-04	20	350	30	70	10,950	25,550
2-Butanone	8.5E-08		3.11E-04	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		2.2E-06	1.91E-02	20	350	30	70	10,950	25,550
Benzene		4.5E-08	3.87E-04	20	350	30	70	10,950	25,550
Tetrachloroethene		4.3E-08	3.67E-04	20	350	30	70	10,950	25,550
Toluene	1.1E-07		3.98E-04	20	350	30	70	10,950	25,550
Chlorobenzene	7.8E-08		2.86E-04	20	350	30	70	10,950	25,550
Ethylbenzene	5.4E-08		1.98E-04	20	350	30	70	10,950	25,550
Xylene (total)			4.45E-04	20	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**CDI (Nc)** (mg/kg-day)	**CDI (Car)** (mg/kg-day)	**RfC** (mg/kg-day)	**Carc. Slope Inhalation** (mg/kg-day)-1	**Hazard Quotient**	**Cancer Risk**
Volatile Organics						
Vinyl Chloride		7.1E-07	NA	2.9E-01		2.1E-07
Chloroethane			2.9E+00	NA		
Acetone			NA	NA		
Carbon Disulfide	4.4E-07		2.9E-03	NA	1.5E-04	
1,1-Dichloroethene		4.7E-07	NA	1.8E-01		8.2E-08
1,2-Dichloroethene (total)	4.1E-06		1.2E+00	NA	3.4E-06	
Chloroform		8.9E-08	NA	8.1E-02		7.2E-09
1,2-Dichloroethane	2.5E-07	1.1E-07	2.9E-03	9.1E-02	8.6E-05	9.7E-09
2-Butanone	8.5E-08		2.9E-01	NA	3.0E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		2.2E-06	NA	6.0E-03		1.3E-08
Benzene		4.5E-08	NA	2.9E-02		1.3E-09
Tetrachloroethene		4.3E-08	NA	2.0E-03		8.6E-11
Toluene	1.1E-07		1.1E-01	NA	9.6E-07	
Chlorobenzene	7.8E-08		5.0E-03	NA	1.6E-05	
Ethylbenzene	5.4E-08		2.9E-01	NA	1.9E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**2.6E-04**	**3.2E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 2

CALCULATION OF INTAKE (ONSITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**Intake (Nc)** (mg/kg-day)	**Intake (Car)** (mg/kg-day)	**95th UCL Air** (ug/m³)	**Inhalation Rate** (m³/day)	**Exposure Frequency** (days/year)	**Exposure Duration** (years)	**Body Weight** (kg)	**Averaging Time** (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		3.0E-06	2.55E-02	20	350	30	70	10,950	25,550
Chloroethane			NA	20	350	30	70	10,950	25,550
Acetone			2.42E-03	20	350	30	70	10,950	25,550
Carbon Disulfide	1.9E-06		6.77E-03	20	350	30	70	10,950	25,550
1,1-Dichloroethene		2.0E-06	1.68E-02	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	1.7E-05		6.26E-02	20	350	30	70	10,950	25,550
Chloroform		3.8E-07	3.21E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethane	1.1E-06	4.5E-07	3.84E-03	20	350	30	70	10,950	25,550
2-Butanone	3.6E-07		1.31E-03	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		9.5E-06	8.06E-02	20	350	30	70	10,950	25,550
Benzene		1.9E-07	1.63E-03	20	350	30	70	10,950	25,550
Tetrachloroethene		1.8E-07	1.55E-03	20	350	30	70	10,950	25,550
Toluene	4.6E-07		1.68E-03	20	350	30	70	10,950	25,550
Chlorobenzene	3.3E-07		1.20E-03	20	350	30	70	10,950	25,550
Ethylbenzene	2.3E-07		8.33E-04	20	350	30	70	10,950	25,550
Xylene (total)			1.88E-03	20	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) =

$$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		3.0E-06	NA	2.9E-01		8.8E-07
Chloroethane			2.9E+00	NA		
Acetone			NA	NA		
Carbon Disulfide	1.9E-06		2.9E-03	NA	6.5E-04	
1,1-Dichloroethene		2.0E-06	NA	1.8E-01		3.5E-07
1,2-Dichloroethene (total)	1.7E-05		1.2E+00	NA	1.4E-05	
Chloroform		3.8E-07	NA	8.1E-02		3.0E-08
1,2-Dichloroethane	1.1E-06	4.5E-07	2.9E-03	9.1E-02	3.6E-04	4.1E-08
2-Butanone	3.6E-07		2.9E-01	NA	1.3E-06	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		9.5E-06	NA	6.0E-03		5.7E-08
Benzene		1.9E-07	NA	2.9E-02		5.6E-09
Tetrachloroethene		1.8E-07	NA	2.0E-03		3.6E-10
Toluene	4.6E-07		1.1E-01	NA	4.0E-06	
Chlorobenzene	3.3E-07		5.0E-03	NA	6.6E-05	
Ethylbenzene	2.3E-07		2.9E-01	NA	8.0E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**1.1E-03**	**1.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

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CASE 2

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR
HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		3.4E-08	2.55E-02	8	10	30	70	10,950	25,550
Chloroethane	0.0E+00		NA	8	10	30	70	10,950	25,550
Acetone			2.42E-03	8	10	30	70	10,950	25,550
Carbon Disulfide	2.1E-08		6.77E-03	8	10	30	70	10,950	25,550
1,1-Dichloroethene		2.3E-08	1.68E-02	8	10	30	70	10,950	25,550
1,2-Dichloroethene (total)	2.0E-07		6.26E-02	8	10	30	70	10,950	25,550
Chloroform		4.3E-09	3.21E-03	8	10	30	70	10,950	25,550
1,2-Dichloroethane	1.2E-08	5.2E-09	3.84E-03	8	10	30	70	10,950	25,550
2-Butanone	4.1E-09		1.31E-03	8	10	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	8	10	30	70	10,950	25,550
Trichloroethene		1.1E-07	8.06E-02	8	10	30	70	10,950	25,550
Benzene		2.2E-09	1.63E-03	8	10	30	70	10,950	25,550
Tetrachloroethene		2.1E-09	1.55E-03	8	10	30	70	10,950	25,550
Toluene	5.3E-09		1.68E-03	8	10	30	70	10,950	25,550
Chlorobenzene	3.8E-09		1.20E-03	8	10	30	70	10,950	25,550
Ethylbenzene	2.6E-09		8.33E-04	8	10	30	70	10,950	25,550
Xylene (total)			1.88E-03	8	10	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	8
EF = Exposure Frequency (days/yr)	10
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		3.4E-08	NA	2.9E-01		1.0E-08
Chloroethane	0.0E+00		2.9E+00	NA	0.0E+00	
Acetone			NA	NA		
Carbon Disulfide	2.1E-08		2.9E-03	NA	7.4E-06	
1,1-Dichloroethene		2.3E-08	NA	1.8E-01		3.9E-09
1,2-Dichloroethene (total)	2.0E-07		1.2E+00	NA	1.6E-07	
Chloroform		4.3E-09	NA	8.1E-02		3.5E-10
1,2-Dichloroethane	1.2E-08	5.2E-09	2.9E-03	9.1E-02	4.1E-06	4.7E-10
2-Butanone	4.1E-09		2.9E-01	NA	1.4E-08	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		1.1E-07	NA	6.0E-03		6.5E-10
Benzene		2.2E-09	NA	2.9E-02		6.4E-11
Tetrachloroethene		2.1E-09	NA	2.0E-03		4.2E-12
Toluene	5.3E-09		1.1E-01	NA	4.6E-08	
Chlorobenzene	3.8E-09		5.0E-03	NA	7.5E-07	
Ethylbenzene	2.6E-09		2.9E-01	NA	9.1E-09	
Xylene (total)			NA	NA		
Total HQ & CR					**1.3E-05**	**1.6E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

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CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.1E-06	NA	2.9E-01		3.1E-07
Chloroethane	0.0E+00		2.9E+00	NA	0.0E+00	
Acetone			NA	NA		
Carbon Disulfide	7.9E-07		2.9E-03	NA	2.8E-04	
1,1-Dichloroethene		7.0E-07	NA	1.8E-01		1.2E-07
1,2-Dichloroethene (total)	7.4E-06		1.2E+00	NA	6.1E-06	
Chloroform		1.3E-07	NA	8.1E-02		1.1E-08
1,2-Dichloroethane	4.5E-07	1.6E-07	2.9E-03	9.1E-02	1.6E-04	1.5E-08
2-Butanone	1.5E-07		2.9E-01	NA	5.4E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		3.4E-06	NA	6.0E-03		2.0E-08
Benzene		6.8E-08	NA	2.9E-02		2.0E-09
Tetrachloroethene		6.5E-08	NA	2.0E-03		1.3E-10
Toluene	2.0E-07		1.1E-01	NA	1.7E-06	
Chlorobenzene	1.4E-07		5.0E-03	NA	2.8E-05	
Ethylbenzene	9.8E-08		2.9E-01	NA	3.4E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**4.7E-04**	**4.9E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

Case 3

CASE 3
CALCULATION OF TOTAL NONCARCINOGENIC AND CARCINOGENIC RISKS

SENECA ARMY DEPOT
ASH LANDFILL

RECEPTOR	EXPOSURE ROUTE	HAZARD INDEX	CANCER RISK
CURRENT RESIDENTIAL			
CURRENT OFF-SITE RESIDENTS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	1.4E-01	5.6E-06
	Dermal Contact to Groundwater	3.2E-03	2.5E-07
	Inhalation of Groundwater while Showering	3.1E-07	1.1E-07
	Inhalation of Volatile Organics in Ambient Air	2.8E-04	3.1E-07
TOTAL RECEPTOR RISK (Nc & CAR)		1.5E-01	1.5E-05
CURRENT AND FUTURE ON SITE			
ON-SITE HUNTERS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Onsite Soils	5.2E-04	2.4E-07
	Dermal Contact to Onsite Soils	6.7E-04	4.2E-08
	Inhalation of Volatile Organics in Ambient Air	1.4E-05	1.5E-08
TOTAL RECEPTOR RISK (Nc & CAR)		6.3E-03	9.5E-06
FUTURE ON-SITE CONSTRUCTION WORKERS	Ingestion of Onsite Soils	7.4E-03	2.0E-06
	Dermal Contact to Onsite Soils	2.5E-02	1.3E-06
	Inhalation of Volatile Organics in Ambient Air	5.1E-04	4.7E-07
TOTAL RECEPTOR RISK (Nc & CAR)		3.3E-02	3.8E-06
TOTAL CURRENT AND INTENDED-FUTURE SITE USE RISKS		1.9E-01	2.9E-05
FUTURE RESIDENTIAL			
FUTURE ON-SITE RESIDENTS	Ingestion of Onsite Soils	1.9E-01	2.3E-05
	Dermal Contact to Onsite Soils	1.8E-01	4.4E-06
	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	3.2E+00	1.4E-03
	Dermal Contact to Groundwater	2.0E-01	7.1E-05
	Inhalation of Groundwater while Showering	1.0E-03	2.9E-05
	Inhalation of Volatile Organics in Ambient Air	1.2E-03	1.3E-06
TOTAL RECEPTOR RISK (Nc & CAR)		3.8E+00	1.5E-03
TOTAL SOIL RISK		4.0E-01	3.3E-05
TOTAL GROUNDWATER RISK		3.6E+00	1.5E-03
TOTAL SEDIMENT RISK		5.9E-03	0.0E+00
TOTAL SURFACE WATER RISK		6.2E-03	1.8E-05
CURRENT SOIL RISK		3.5E-02	4.4E-06
FUTURE SOIL RISK		3.7E-01	2.8E-05

CASE 3

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SURFACE SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	COUNT	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration	STD.DEV
Volatile Organics								
Vinyl Chloride	ug/kg	200	26	7	6.14	6.02	6.14	0.39
1,2-Dichloroethene (total)	ug/kg	300	26	7	4.50	4.02	4.50	1.49
Trichloroethene	ug/kg	700	26	98	8.76	8.25	8.76	18.41
Semi-volatiles								
2-Methylnaphthalene	ug/kg	36,400	26	1250	413.82	342.35	413.82	221.56
Acenaphthylene	ug/kg	41,000	12	510	259.59	190.08	259.59	146.37
Dibenzofuran	ug/kg	6,200	26	1250	444.56	363.58	444.56	251.02
Phenanthrene	ug/kg	50,000	26	15000	1,180.39	927.85	1,180.39	2,887.97
Benzo(a)anthracene	ug/kg	220 or MDL	26	9600	1,141.22	718.08	1,141.22	1,831.25
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	26	230000	2,952.90	9,303.77	2,952.90	45,015.06
Benzo(b)fluoranthene	ug/kg	1,100	26	9500	957.31	724.88	957.31	1,805.94
Benzo(k)fluoranthene	ug/kg	1,100	26	6100	826.02	580.88	826.02	1,144.84
Benzo(a)pyrene	ug/kg	61 or MDL	26	8400	1,013.62	687.50	1,013.62	1,600.36
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	26	4600	738.92	470.88	738.92	856.06
Dibenz(a,h)anthracene	ug/kg	14 or MDL	26	1800	510.91	395.12	510.91	358.92
Benzo(g,h,i)perylene	ug/kg	50,000	26	4000	773.32	500.35	773.32	754.55
Pesticides/PCB's								
Aroclor-1260	ug/kg	1,000	26	220	154.25	127.81	154.25	81.98
Metals								
Cadmium	mg/kg	1.74	26	8.2	2.58	2.02	2.58	1.74
Chromium	mg/kg	26.49	26	49	30.30	28.25	30.30	6.36
Copper	mg/kg	25	26	177	45.72	35.52	45.72	31.61
Lead	mg/kg	30	21	1170	101.67	87.16	101.67	250.48
Zinc	mg/kg	88.89	26	745	207.44	165.06	207.44	170.44

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CASE 3

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics						
Vinyl Chloride	ug/kg	200	17	6.20	5.97	6.20
1,2-Dichloroethene (total)	ug/kg	300	210	7.43	9.68	7.43
Trichloroethene	ug/kg	700	540	14.82	20.16	14.82
Semivolatiles						
2-Methylnaphthalene	ug/kg	36,400	1,600	377.88	332.33	377.88
Acenaphthylene	ug/kg	41,000	510	270.67	243.80	270.67
Dibenzofuran	ug/kg	6,200	7,000	419.77	397.44	419.77
Phenanthrene	ug/kg	50,000	43,000	914.49	1,191.73	914.49
Benzo(a)anthracene	ug/kg	220 or MDL	9,600	648.14	592.46	648.14
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	230,000	1,114.46	3,749.24	1,114.46
Benzo(b)fluoranthene	ug/kg	1,100	9,500	581.41	554.80	581.41
benzo(k)fluoranthene	ug/kg	1,100	6,100	527.17	476.05	527.17
Benzo(a)pyrene	ug/kg	61 or MDL	8,400	571.60	518.47	571.60
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	4,600	461.24	392.75	461.24
Dibenz(a,h)anthracene	ug/kg	14 or MDL	2,900	439.98	372.28	439.98
Benzo(g,h,i)perylene	ug/kg	50,000	4,000	440.32	389.86	440.32
Pesticides/PCBs						
Aroclor-1260	ug/kg	1,000	220	133.01	118.60	133.01
Metals						
Cadmium	mg/kg	1.74	11.4	2.51	2.14	2.51
Chromium	mg/kg	26.49	52.4	28.90	27.61	28.90
Copper	mg/kg	25	311	37.41	36.18	37.41
Lead	mg/kg	30	2,610	90.77	103.05	90.77
Zinc	mg/kg	88.89	3,100	218.77	231.20	218.77

CASE 3
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																Child(Nc)	Adult(Nc)	Car
Volatile Organics																		
Vinyl Chloride	9.6E-09		6.7E-09		2.9E-09	6.14E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dichloroethene, 1,2- (total)		5.8E-08		6.2E-09		4.50E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trichloroethene	1.4E-08		9.6E-09		4.1E-09	8.76E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Semi-volatiles																		
Methylnaphthalene, 2-						4.14E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Acenaphthylene						2.60E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzofuran						4.45E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene						1.18E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.8E-06		1.3E-06		5.4E-07	1.14E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
bis(2-Ethylhexyl)phthalate	4.6E-06	3.8E-05	3.2E-06	4.0E-06	1.4E-06	2.95E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.5E-06		1.0E-06		4.5E-07	9.57E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.3E-06		9.1E-07		3.9E-07	8.26E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.6E-06		1.1E-06		4.8E-07	1.01E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.2E-06		8.1E-07		3.5E-07	7.39E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	8.0E-07		5.6E-07		2.4E-07	5.11E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene						7.73E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCB's																		
Aroclor-1260	2.4E-07		1.7E-07		7.2E-08	1.54E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																		
Cadmium		3.3E-05		3.5E-06		2.58E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium VI		3.9E-04		4.2E-05		3.03E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper		5.8E-04		6.3E-05		4.57E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead						1.02E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc		2.7E-03		2.8E-04		2.07E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	**95th UCL Soil Data**
IR = Ingestion Rate (mg soil/day)	**100 (Adult)/ 200 (Child)**
CF = Conversion Factor (10-6 kg/mg)	**10-6**
FI = Fraction Ingested (unitless)	**1**
EF = Exposure Frequency (days/years)	**350 events/year**
ED = Exposure Duration (years)	**30 years**
BW = Bodyweight (kg)	**70 (Adult male)/ 15 (Child 6-7)**
AT = Averaging Time (days)	**6 x 365 Child 24 x 365 Adult (NC)** **70 x 365 (C)**

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CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Vinyl Chloride			9.6E-09	NA	1.9E+00				1.8E-08
Dichloroethene, 1,2- (total)	6.17E-09	5.8E-08		9.0E-03	NA	6.9E-07	6.4E-06	7.1E-06	
Trichloroethene			1.4E-08	NA	1.1E-02				1.5E-10
Semi-volatiles									
Methylnaphthalene, 2-				NA	NA				
Acenaphthylene				NA	NA				
Dibenzofuran				NA	NA				
Phenanthrene				NA	NA				
Benzo(a)anthracene			1.8E-06	NA	7.3E-01				1.3E-06
bis(2-Ethylhexyl)phthalate	4.05E-06	3.8E-05	4.6E-06	2.0E-02	1.4E-02	2.0E-04	1.9E-03	2.1E-03	6.5E-08
Benzo(b)fluoranthene			1.5E-06	NA	7.3E-01				1.1E-06
Benzo(k)fluoranthene			1.3E-06	NA	7.3E-02				9.4E-08
Benzo(a)pyrene			1.6E-06	NA	7.3E+00				1.2E-05
Indeno(1,2,3-cd)pyrene			1.2E-06	NA	7.3E-01				8.4E-07
Dibenzo(a,h)anthracene			8.0E-07	NA	7.3E+00				5.8E-06
Benzo(g,h,i)perylene				NA	NA				
Pesticides/PCB's									
Aroclor-1260			2.4E-07	NA	7.7E+00				1.9E-06
Metals									
Cadmium	3.53E-06	3.3E-05		5.0E-04	NA	7.1E-03	6.6E-02	7.3E-02	
Chromium VI	4.15E-05	3.9E-04		5.0E-03	NA	8.3E-03	7.7E-02	8.6E-02	
Copper	6.26E-05	5.8E-04		4.0E-02	NA	1.6E-03	1.5E-02	1.6E-02	
Lead				NA	NA				
Zinc	2.84E-04	2.7E-03		3.0E-01	NA	9.5E-04	8.8E-03	9.8E-03	
Totals - HQ & CR								**1.9E-01**	**2.3E-05**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		1.3E-09	6.20E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Dichloroethene, 1,2- (total)	4.4E-09		7.43E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Trichloroethene		3.1E-09	1.48E-02	100	1.0E-06	1	150	25	70	9,125	25,550
Semi-volatiles											
Methylnaphthalene, 2-			3.78E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Acenaphthylene			2.71E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzofuran			4.20E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			9.14E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		1.4E-07	6.48E-01	100	1.0E-06	1	150	25	70	9,125	25,550
bis(2-Ethylhexyl)phthalate	6.5E-07	2.3E-07	1.11E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		1.2E-07	5.81E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		1.1E-07	5.27E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		1.2E-07	5.72E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		9.7E-08	4.61E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		9.2E-08	4.40E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			4.40E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Aroclor-1260		2.8E-08	1.33E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Cadmium	1.5E-06		2.51E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Chromium VI	1.7E-05		2.89E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Copper	2.2E-05		3.74E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Lead			9.08E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Zinc	1.3E-04		2.19E+02	100	1.0E-06	1	150	25	70	9,125	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	150 events/year
ED = Exposure Duration (years)	25 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

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CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.3E-09	NA	1.9E+00		2.5E-09
Dichloroethene, 1,2- (total)	4.4E-09		9.0E-03	NA	4.8E-07	
Trichloroethene		3.1E-09	NA	1.1E-02		3.4E-11
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		1.4E-07	NA	7.3E-01		9.9E-08
bis(2-Ethylhexyl)phthalate	6.5E-07	2.3E-07	2.0E-02	1.4E-02	3.3E-05	3.3E-09
Benzo(b)fluoranthene		1.2E-07	NA	7.3E-01		8.9E-08
Benzo(k)fluoranthene		1.1E-07	NA	7.3E-02		8.1E-09
Benzo(a)pyrene		1.2E-07	NA	7.3E+00		8.7E-07
Indeno(1,2,3-cd)pyrene		9.7E-08	NA	7.3E-01		7.1E-08
Dibenzo(a,h)anthracene		9.2E-08	NA	7.3E+00		6.7E-07
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		2.8E-08	NA	7.7E+00		2.1E-07
Metals						
Cadmium	1.5E-06		5.0E-04	NA	3.0E-03	
Chromium VI	1.7E-05		5.0E-03	NA	3.4E-03	
Copper	2.2E-05		4.0E-02	NA	5.5E-04	
Lead			NA	NA		
Zinc	1.3E-04		3.0E-01	NA	4.3E-04	
Totals - HQ & CR					**7.4E-03**	**2.0E-06**

Hazard Quotient = **Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)**
Cancer Risk = **Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)**

CASE 3
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics											
Vinyl Chloride		1.0E-10	6.14E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Dichloroethene, 1,2- (total)	1.8E-10		4.50E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Trichloroethene		1.5E-10	8.76E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Semi-volatiles											
Methylnaphthalene, 2-			4.14E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Acenaphthylene			2.60E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzofuran			4.45E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Phenanthrene			1.18E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)anthracene		1.9E-08	1.14E+00	100	1.0E-06	1	10	30	70	10,950	25,550
bis(2-Ethylhexyl)phthalate	1.2E-07	5.0E-08	2.95E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(b)fluoranthene		1.6E-08	9.57E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(k)fluoranthene		1.4E-08	8.26E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)pyrene		1.7E-08	1.01E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene		1.2E-08	7.39E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzo(a,h)anthracene		8.6E-09	5.11E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(g,h,i)perylene			7.73E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Pesticides/PCB's											
Aroclor-1260		2.6E-09	1.54E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Metals											
Cadmium	1.0E-07		2.58E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Chromium VI	1.2E-06		3.03E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Copper	1.8E-06		4.57E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Lead			1.02E+02	100	1.0E-06	1	10	30	70	10,950	25,550
Zinc	8.1E-06		2.07E+02	100	1.0E-06	1	10	30	70	10,950	25,550

Intake (mg/kg-day) =

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	10 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.0E-10	NA	1.9E+00		2.0E-10
Dichloroethene, 1,2- (total)	1.8E-10		9.0E-03	NA	2.0E-08	
Trichloroethene		1.5E-10	NA	1.1E-02		1.6E-12
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		1.9E-08	NA	7.3E-01		1.4E-08
bis(2-Ethylhexyl)phthalate	1.2E-07	5.0E-08	2.0E-02	1.4E-02	5.8E-06	6.9E-10
Benzo(b)fluoranthene		1.6E-08	NA	7.3E-01		1.2E-08
Benzo(k)fluoranthene		1.4E-08	NA	7.3E-02		1.0E-09
Benzo(a)pyrene		1.7E-08	NA	7.3E+00		1.2E-07
Indeno(1,2,3-cd)pyrene		1.2E-08	NA	7.3E-01		9.0E-09
Dibenzo(a,h)anthracene		8.6E-09	NA	7.3E+00		6.3E-08
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		2.6E-09	NA	7.7E+00		2.0E-08
Metals						
Cadmium	1.0E-07		5.0E-04	NA	2.0E-04	
Chromium VI	1.2E-06		5.0E-03	NA	2.4E-04	
Copper	1.8E-06		4.0E-02	NA	4.5E-05	
Lead			NA	NA		
Zinc	8.1E-06		3.0E-01	NA	2.7E-05	
Totals - HQ & CR					**5.2E-04**	**2.4E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm^2)	Adherence Factor (mg soil/cm^2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		5.2E-09	1.54E-01	1.0E-06	2,000	1.0	0.1	10	30	70	10,950	25,550
Metals												
Cadmium	2.0E-08		2.58E+00	1.0E-06	2,000	1.0	0.01	10	30	70	10,950	25,550

EQUATION:

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**	**Variables:**	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	**95th UCL Soil Data**	**EF = Exposure Frequency (days/year)**	**10 events/year**
CF = Conversion Factor (10-6 kg/mg)	**10-6**	**ED = Exposure Duration (years)**	**30 years**
SA = Surface Area Contact (cm^2)	**2000 cm^2 (Adult)**	**BW = Bodyweight (kg)**	**70 kg (adult)**
AF =Soil to Skin Adherence Factor (mg/cm^2)	**1**	**AT = Averaging Time (days)**	**30 x 365 (Nc) 70 x 365 Adult (Car)**
ABS = Absorption Factor (unitless)	**0.01**		

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		5.2E-09	NA	8.1E+00		4.2E-08
Metals						
Cadmium	2.0E-08		3.0E-05	NA	6.7E-04	
Totals - HQ & CR					**6.7E-04**	**4.2E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3
CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm^2)	Adherence Factor (mg soil/cm^2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		1.6E-07	1.54E-01	1.0E-06	5,000	1.0	0.1	150	25	70	9,125	25,550
Metals												
Cadmium	7.6E-07		2.58E+00	1.0E-06	5,000	1.0	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) =

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)	EF = Exposure Frequency (days/year)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm^2)	5000(A)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm^2)	1.00	AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)
ABS = Absorption Factor (unitless)	varies EPA, 1992		

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		1.6E-07	NA	8.1E+00		1.3E-06
Metals						
Cadmium	7.6E-07		3.0E-05	NA	2.5E-02	
Totals - HQ & CR					**2.5E-02**	**1.3E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm^2)	Adult Skin Surface Area Contact (cm^2)	Adherence Factor (mg soil/cm^2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Volatile Organics																			
Semi-volatiles																			
Pesticides/PCB's																			
Aroclor-1260	5.5E-07		1.8E-07		3.6E-07	1.54E-01	1.0E-06	2,165	5,000	1.0	0.1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Cadmium	0.0E+00	3.6E-06		1.8E-06		2.58E+00	1.0E-06	2,165	5,000	1.0	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) =

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm^2)	2165(C)/5000(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm^2)	1.00	AT = Averaging Time (days)	6 x 365 Child 24 x 365 Adult (Nc)
ABS = Absorption Factor (unitless)	varies EPA, 1992		70 x 365 (Car)

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Semi-volatiles									
Pesticides/PCB's									
Aroclor-1260			5.5E-07	NA	8.1E+00				4.4E-06
Metals									
Cadmium	1.8E-06	3.6E-06	0.0E+00	3.0E-05	NA	5.9E-02	1.2E-01	1.8E-01	
Totals - HQ & CR								**1.8E-01**	**4.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3
SENECA ARMY DEPOT
ASH LANDFILL-HOT SPOT
SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)
POTENTIAL CHEMICALS OF CONCERN

COMPOUND	units	NYSDEC TAGM	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD.DEV	COEF OF VARIATION	NORMAL/ LOGNORMAL
Volatile Organics									
Vinyl Chloride	ug/kg		16	17	7.66	6.56	2.66	0.41	NORMAL
Chloroethane	ug/kg		0	NA	NA	NA	0.00	NA	NA
Acetone	ug/kg		16	8	6.67	6.34	0.79	0.12	NORMAL
Carbon Disulfide	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
1,1-Dichloroethene	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
1,2-Dichloroethene (total)	ug/kg		16	210	74.69	30.47	66.41	2.18	LOGNORMAL
Chloroform	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
1,2-Dichloroethane	ug/kg		16	21	7.98	6.28	4.12	0.66	NORMAL
2-Butanone	ug/kg		16	17	7.66	6.56	2.66	0.41	NORMAL
1,1,1-Trichloroethane	ug/kg		0	NA	NA	NA	0.00	NA	NA
Trichloroethene	ug/kg		16	540	191.78	63.25	137.17	2.17	LOGNORMAL
Benzene	ug/kg		3	3	3.11	2.83	0.29	0.10	NORMAL
Tetrachloroethene	ug/kg		3	3	3.11	2.83	0.29	0.10	NORMAL
Toluene	ug/kg		16	9	6.18	5.63	1.35	0.24	NORMAL
Chlorobenzene	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
Ethylbenzene	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
Xylene (total)	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL

CASE 3

CALCULATION OF VOLATILE ORGANIC COMPOUNDS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	Off-Site Conc. ug/m^3	On-Site Conc. ug/m^3	Average Emission Rate Ei g/s	Effective Diffusivity Dei cm^2/s	Molecular Diffusivity Di cm^2/s	Bulk Soil Concentration Ci g/g	Exposure Interval t sec.	Soil Porosity ε	Exposed Surface Area A cm^2	Constant a	Soil/Air Partition Coef. Kas g/cm^3
Volatile Organics											
Vinyl Chloride	0.006	0.027	9.3115E-06	0.074023	0.102103	7.6580E-09	9.10E+08	0.38	6.82E+07	2.98E-02	2.95
Chloroethane	NA	NA	NA	0.0718	0.099037	0.0000E+00	9.10E+08	0.38	6.82E+07	1.20E-03	0.07
Acetone	0.000	0.001	4.9685E-07	0.071065	0.098023	6.6686E-09	9.10E+08	0.38	6.82E+07	3.11E-04	0.02
Carbon Disulfide	0.002	0.007	2.4399E-06	0.076044	0.10489	6.1146E-09	9.10E+08	0.38	6.82E+07	7.34E-03	0.47
1,1-Dichloroethene	0.002	0.010	3.5668E-06	0.062898	0.086758	6.1146E-09	9.10E+08	0.38	6.82E+07	1.24E-02	1.07
1,2-Dichloroethene (total)	0.013	0.054	1.8465E-05	0.062898	0.086758	7.4692E-08	9.10E+08	0.38	6.82E+07	3.12E-03	0.23
Chloroform	0.001	0.003	1.1580E-06	0.068672	0.094722	6.1146E-09	9.10E+08	0.38	6.82E+07	1.91E-03	0.13
1,2-Dichloroethane	0.001	0.004	1.5311E-06	0.061481	0.084803	7.9768E-09	9.10E+08	0.38	6.82E+07	1.95E-03	0.14
2-Butanone	0.000	0.001	4.2855E-07	0.061749	0.085173	7.6580E-09	9.10E+08	0.38	6.82E+07	1.76E-04	0.01
1,1,1-Trichloroethane	0.000	0.000	0.0000E+00	0.055018	0.075889	0.0000E+00	9.10E+08	0.38	6.82E+07	2.34E-03	0.19
Trichloroethene	0.025	0.104	3.5755E-05	0.056046	0.077306	1.9178E-07	9.10E+08	0.38	6.82E+07	1.84E-03	0.15
Benzene	0.000	0.002	5.7884E-07	0.06013	0.08294	3.1075E-09	9.10E+08	0.38	6.82E+07	1.84E-03	0.14
Tetrachloroethene	0.000	0.002	5.4945E-07	0.051194	0.070614	3.1075E-09	9.10E+08	0.38	6.82E+07	1.65E-03	0.15
Toluene	0.000	0.002	6.0664E-07	0.054111	0.074637	6.1793E-09	9.10E+08	0.38	6.82E+07	5.33E-04	0.04
Chlorobenzene	0.000	0.001	4.3401E-07	0.053528	0.073833	6.1146E-09	9.10E+08	0.38	6.82E+07	2.81E-04	0.02
Ethylbenzene	0.000	0.001	3.0036E-07	0.049563	0.068364	6.1146E-09	9.10E+08	0.38	6.82E+07	1.35E-04	0.01
Xylene (total)	0.000	0.002	6.7652E-07	0.049563	0.068364	6.1146E-09	9.10E+08	0.38	6.82E+07	6.72E-04	0.06

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CASE 3

CALCULATION OF INTAKE (OFF-SITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		7.6E-07	6.43E-03	20	350	30	70	10,950	25,550
Chloroethane			NA	20	350	30	70	10,950	25,550
Acetone			3.43E-04	20	350	30	70	10,950	25,550
Carbon Disulfide	4.6E-07		1.69E-03	20	350	30	70	10,950	25,550
1,1-Dichloroethene		2.9E-07	2.46E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	3.5E-06		1.28E-02	20	350	30	70	10,950	25,550
Chloroform		9.4E-08	8.00E-04	20	350	30	70	10,950	25,550
1,2-Dichloroethane	2.9E-07	1.2E-07	1.06E-03	20	350	30	70	10,950	25,550
2-Butanone	8.1E-08		2.96E-04	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		2.9E-06	2.47E-02	20	350	30	70	10,950	25,550
Benzene		4.7E-08	4.00E-04	20	350	30	70	10,950	25,550
Tetrachloroethene		4.5E-08	3.80E-04	20	350	30	70	10,950	25,550
Toluene	1.1E-07		4.19E-04	20	350	30	70	10,950	25,550
Chlorobenzene	8.2E-08		3.00E-04	20	350	30	70	10,950	25,550
Ethylbenzene	5.7E-08		2.08E-04	20	350	30	70	10,950	25,550
Xylene (total)			4.67E-04	20	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		7.6E-07	NA	2.9E-01		2.2E-07
Chloroethane			2.9E+00	NA		
Acetone			NA	NA		
Carbon Disulfide	4.6E-07		2.9E-03	NA	1.6E-04	
1,1-Dichloroethene		2.9E-07	NA	1.8E-01		5.1E-08
1,2-Dichloroethene (total)	3.5E-06		1.2E+00	NA	2.9E-06	
Chloroform		9.4E-08	NA	8.1E-02		7.6E-09
1,2-Dichloroethane	2.9E-07	1.2E-07	2.9E-03	9.1E-02	1.0E-04	1.1E-08
2-Butanone	8.1E-08		2.9E-01	NA	2.8E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		2.9E-06	NA	6.0E-03		1.7E-08
Benzene		4.7E-08	NA	2.9E-02		1.4E-09
Tetrachloroethene		4.5E-08	NA	2.0E-03		8.9E-11
oluene	1.1E-07		1.1E-01	NA	1.0E-06	
hlorobenzene	8.2E-08		5.0E-03	NA	1.6E-05	
Ethylbenzene	5.7E-08		2.9E-01	NA	2.0E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**2.8E-04**	**3.1E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 3

CALCULATION OF INTAKE (ONSITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT ASH LANDFILL

Analyte	**Intake (Nc)** (mg/kg-day)	**Intake (Car)** (mg/kg-day)	**95th UCL Air** (ug/m³)	**Inhalation Rate** (m³/day)	**Exposure Frequency** (days/year)	**Exposure Duration** (years)	**Body Weight** (kg)	**Averaging Time** (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		3.2E-06	2.71E-02	20	350	30	70	10,950	25,550
Chloroethane			NA	20	350	30	70	10,950	25,550
Acetone			1.45E-03	20	350	30	70	10,950	25,550
Carbon Disulfide	1.9E-06		7.11E-03	20	350	30	70	10,950	25,550
1,1-Dichloroethene		1.2E-06	1.04E-02	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	1.5E-05		5.38E-02	20	350	30	70	10,950	25,550
Chloroform		4.0E-07	3.37E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethane	1.2E-06	5.2E-07	4.46E-03	20	350	30	70	10,950	25,550
2-Butanone	3.4E-07		1.25E-03	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		1.2E-05	1.04E-01	20	350	30	70	10,950	25,550
Benzene		2.0E-07	1.69E-03	20	350	30	70	10,950	25,550
Tetrachloroethene		1.9E-07	1.60E-03	20	350	30	70	10,950	25,550
Toluene	4.8E-07		1.77E-03	20	350	30	70	10,950	25,550
Chlorobenzene	3.5E-07		1.26E-03	20	350	30	70	10,950	25,550
Ethylbenzene	2.4E-07		8.75E-04	20	350	30	70	10,950	25,550
Xylene (total)			1.97E-03	20	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

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CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		3.2E-06	NA	2.9E-01		9.4E-07
Chloroethane			2.9E+00	NA		
Acetone			NA	NA		
Carbon Disulfide	1.9E-06		2.9E-03	NA	6.8E-04	
1,1-Dichloroethene		1.2E-06	NA	1.8E-01		2.1E-07
1,2-Dichloroethene (total)	1.5E-05		1.2E+00	NA	1.2E-05	
Chloroform		4.0E-07	NA	8.1E-02		3.2E-08
1,2-Dichloroethane	1.2E-06	5.2E-07	2.9E-03	9.1E-02	4.2E-04	4.8E-08
2-Butanone	3.4E-07		2.9E-01	NA	1.2E-06	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		1.2E-05	NA	6.0E-03		7.3E-08
Benzene		2.0E-07	NA	2.9E-02		5.8E-09
Tetrachloroethene		1.9E-07	NA	2.0E-03		3.8E-10
Toluene	4.8E-07		1.1E-01	NA	4.2E-06	
Chlorobenzene	3.5E-07		5.0E-03	NA	6.9E-05	
Ethylbenzene	2.4E-07		2.9E-01	NA	8.4E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**1.2E-03**	**1.3E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

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CASE 3

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR
HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		3.6E-08	2.71E-02	8	10	30	70	10,950	25,550
Chloroethane	0.0E+00		NA	8	10	30	70	10,950	25,550
Acetone			1.45E-03	8	10	30	70	10,950	25,550
Carbon Disulfide	2.2E-08		7.11E-03	8	10	30	70	10,950	25,550
1,1-Dichloroethene		1.4E-08	1.04E-02	8	10	30	70	10,950	25,550
1,2-Dichloroethene (total)	1.7E-07		5.38E-02	8	10	30	70	10,950	25,550
Chloroform		4.5E-09	3.37E-03	8	10	30	70	10,950	25,550
1,2-Dichloroethane	1.4E-08	6.0E-09	4.46E-03	8	10	30	70	10,950	25,550
2-Butanone	3.9E-09		1.25E-03	8	10	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	8	10	30	70	10,950	25,550
Trichloroethene		1.4E-07	1.04E-01	8	10	30	70	10,950	25,550
Benzene		2.3E-09	1.69E-03	8	10	30	70	10,950	25,550
Tetrachloroethene		2.1E-09	1.60E-03	8	10	30	70	10,950	25,550
Toluene	5.5E-09		1.77E-03	8	10	30	70	10,950	25,550
Chlorobenzene	4.0E-09		1.26E-03	8	10	30	70	10,950	25,550
Ethylbenzene	2.7E-09		8.75E-04	8	10	30	70	10,950	25,550
Xylene (total)			1.97E-03	8	10	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	8
EF = Exposure Frequency (days/yr)	10
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		3.6E-08	NA	2.9E-01		1.1E-08
Chloroethane	0.0E+00		2.9E+00	NA	0.0E+00	
Acetone			NA	NA		
Carbon Disulfide	2.2E-08		2.9E-03	NA	7.8E-06	
1,1-Dichloroethene		1.4E-08	NA	1.8E-01		2.4E-09
1,2-Dichloroethene (total)	1.7E-07		1.2E+00	NA	1.4E-07	
Chloroform		4.5E-09	NA	8.1E-02		3.6E-10
1,2-Dichloroethane	1.4E-08	6.0E-09	2.9E-03	9.1E-02	4.8E-06	5.4E-10
2-Butanone	3.9E-09		2.9E-01	NA	1.4E-08	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		1.4E-07	NA	6.0E-03		8.4E-10
Benzene		2.3E-09	NA	2.9E-02		6.6E-11
Tetrachloroethene		2.1E-09	NA	2.0E-03		4.3E-12
Toluene	5.5E-09		1.1E-01	NA	4.8E-08	
Chlorobenzene	4.0E-09		5.0E-03	NA	7.9E-07	
Ethylbenzene	2.7E-09		2.9E-01	NA	9.6E-09	
Xylene (total)			NA	NA		
Total HQ & CR					**1.4E-05**	**1.5E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 3

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**Intake (Nc)** (mg/kg-day)	**Intake (Car)** (mg/kg-day)	**95th UCL Air** (ug/m³)	**Inhalation Rate** (m³/day)	**Exposure Frequency** (days/year)	**Exposure Duration** (years)	**Body Weight** (kg)	**Averaging Time** (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		1.1E-06	2.71E-02	20	150	25	70	9,125	25,550
Chloroethane	0.0E+00		NA	20	150	25	70	9,125	25,550
Acetone			1.45E-03	20	150	25	70	9,125	25,550
Carbon Disulfide	8.3E-07		7.11E-03	20	150	25	70	9,125	25,550
1,1-Dichloroethene		4.4E-07	1.04E-02	20	150	25	70	9,125	25,550
1,2-Dichloroethene (total)	6.3E-06		5.38E-02	20	150	25	70	9,125	25,550
Chloroform		1.4E-07	3.37E-03	20	150	25	70	9,125	25,550
1,2-Dichloroethane	5.2E-07	1.9E-07	4.46E-03	20	150	25	70	9,125	25,550
2-Butanone	1.5E-07		1.25E-03	20	150	25	70	9,125	25,550
1,1,1-Trichloroethane			0.00E+00	20	150	25	70	9,125	25,550
Trichloroethene		4.4E-06	1.04E-01	20	150	25	70	9,125	25,550
Benzene		7.1E-08	1.69E-03	20	150	25	70	9,125	25,550
Tetrachloroethene		6.7E-08	1.60E-03	20	150	25	70	9,125	25,550
Toluene	2.1E-07		1.77E-03	20	150	25	70	9,125	25,550
Chlorobenzene	1.5E-07		1.26E-03	20	150	25	70	9,125	25,550
Ethylbenzene	1.0E-07		8.75E-04	20	150	25	70	9,125	25,550
Xylene (total)			1.97E-03	20	150	25	70	9,125	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

07/14/94

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.1E-06	NA	2.9E-01		3.3E-07
Chloroethane	0.0E+00		2.9E+00	NA	0.0E+00	
Acetone			NA	NA		
Carbon Disulfide	8.3E-07		2.9E-03	NA	2.9E-04	
1,1-Dichloroethene		4.4E-07	NA	1.8E-01		7.6E-08
1,2-Dichloroethene (total)	6.3E-06		1.2E+00	NA	5.3E-06	
Chloroform		1.4E-07	NA	8.1E-02		1.1E-08
1,2-Dichloroethane	5.2E-07	1.9E-07	2.9E-03	9.1E-02	1.8E-04	1.7E-08
2-Butanone	1.5E-07		2.9E-01	NA	5.1E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		4.4E-06	NA	6.0E-03		2.6E-08
Benzene		7.1E-08	NA	2.9E-02		2.1E-09
Tetrachloroethene		6.7E-08	NA	2.0E-03		1.3E-10
oluene	2.1E-07		1.1E-01	NA	1.8E-06	
Chlorobenzene	1.5E-07		5.0E-03	NA	3.0E-05	
Ethylbenzene	1.0E-07		2.9E-01	NA	3.6E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**5.1E-04**	**4.7E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

Case 4

CASE 4
CALCULATION OF TOTAL NONCARCINOGENIC AND CARCINOGENIC RISKS

SENECA ARMY DEPOT
ASH LANDFILL

RECEPTOR	EXPOSURE ROUTE	HAZARD INDEX	CANCER RISK
CURRENT RESIDENTIAL			
CURRENT OFF-SITE RESIDENTS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	1.4E-01	5.6E-06
	Dermal Contact to Groundwater	3.2E-03	2.5E-07
	Inhalation of Groundwater while Showering	3.1E-07	1.1E-07
	Inhalation of Volatile Organics in Ambient Air	2.8E-04	3.1E-07
TOTAL RECEPTOR RISK (Nc & CAR)		1.5E-01	1.5E-05
CURRENT AND FUTURE ON SITE			
ON-SITE HUNTERS	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Onsite Soils	4.9E-04	1.5E-07
	Dermal Contact to Onsite Soils	7.4E-04	4.6E-08
	Inhalation of Volatile Organics in Ambient Air	1.4E-05	1.5E-08
TOTAL RECEPTOR RISK (Nc & CAR)		6.3E-03	9.4E-06
FUTURE ON-SITE CONSTRUCTION WORKERS	Ingestion of Onsite Soils	7.0E-03	1.6E-06
	Dermal Contact to Onsite Soils	2.8E-02	1.4E-06
	Inhalation of Volatile Organics in Ambient Air	5.1E-04	4.7E-07
TOTAL RECEPTOR RISK (Nc & CAR)		3.5E-02	3.5E-06
TOTAL CURRENT AND INTENDED-FUTURE SITE USE RISKS		1.9E-01	2.8E-05
FUTURE RESIDENTIAL			
FUTURE ON-SITE RESIDENTS	Ingestion of Onsite Soils	1.8E-01	1.4E-05
	Dermal Contact to Onsite Soils	2.0E-01	4.9E-06
	Dermal Contact to Surface Water while Wading	3.1E-03	9.2E-06
	Dermal Contact to Sediment while Wading	2.0E-03	0.0E+00
	Ingestion of Groundwater	3.2E+00	1.4E-03
	Dermal Contact to Groundwater	2.0E-01	7.1E-05
	Inhalation of Groundwater while Showering	1.0E-03	2.9E-05
	Inhalation of Volatile Organics in Ambient Air	1.2E-03	1.3E-06
TOTAL RECEPTOR RISK (Nc & CAR)		3.8E+00	1.5E-03
TOTAL SOIL RISK		4.1E-01	2.4E-05
TOTAL GROUNDWATER RISK		3.6E+00	1.5E-03
TOTAL SEDIMENT RISK		5.9E-03	0.0E+00
TOTAL SURFACE WATER RISK		6.2E-03	1.8E-05
CURRENT SOIL RISK		3.7E-02	4.0E-06
FUTURE SOIL RISK		3.8E-01	2.0E-05

07/15/94

CASE 4

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SURFACE SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	COUNT	MAXIMUM	95th UCL of the mean	MEAN	Exposure Point Concentration	STD.DEV
Volatile Organics								
Vinyl Chloride	ug/kg	200	20	7	6.23	6.10	6.23	0.35
1,2-Dichloroethene (total)	ug/kg	300	20	7	4.12	3.63	4.12	1.36
Trichloroethene	ug/kg	700	20	9	5.12	4.38	5.12	2.03
Semi-volatiles								
2-Methylnaphthalene	ug/kg	36,400	20	450	371.32	339.25	371.32	87.20
Acenaphthylene	ug/kg	41,000	8	510	333.00	268.75	333.00	110.48
Dibenzofuran	ug/kg	6,200	20	450	371.32	339.25	371.32	87.20
Phenanthrene	ug/kg	50,000	20	1700	496.48	372.05	496.48	338.28
Benzo(a)anthracene	ug/kg	220 or MDL	20	1300	484.32	381.85	484.32	278.58
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	20	650	430.65	387.65	430.65	116.91
Benzo(b)fluoranthene	ug/kg	1,100	20	740	416.38	354.75	416.38	167.55
Benzo(k)fluoranthene	ug/kg	1,100	20	870	431.85	362.95	431.85	187.31
Benzo(a)pyrene	ug/kg	61 or MDL	20	1500	507.56	396.30	507.56	302.47
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	20	660	385.73	332.90	385.73	143.62
Dibenz(a,h)anthracene	ug/kg	14 or MDL	20	450	367.39	335.75	367.39	86.03
Benzo(g,h,i)perylene	ug/kg	50,000	20	880	413.72	354.10	413.72	162.08
Pesticides/PCB's								
Aroclor-1260	ug/kg	1,000	20	220	169.76	140.18	169.76	80.43
Metals								
Cadmium	mg/kg	1.74	20	8.2	2.85	2.17	2.85	1.86
Chromium	mg/kg	26.49	20	35	28.41	26.83	28.41	4.30
Copper	mg/kg	25	20	52	30.35	27.52	30.35	7.69
Lead	mg/kg	30	15	40	24.96	20.25	24.96	11.09
Zinc	mg/kg	88.89	20	335	142.32	117.39	142.32	67.80

CASE 4

EXPOSURE POINT CONCENTRATIONS-CHEMICALS OF CONCERN
SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	UNITS	NYSDEC TAGM	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics						
Vinyl Chloride	ug/kg	200	17	6.30	5.98	6.30
1,2-Dichloroethene (total)	ug/kg	300	210	7.25	10.71	7.25
Trichloroethene	ug/kg	700	540	13.60	19.93	13.60
Semivolatiles						
2-Methylnaphthalene	ug/kg	36,400	450	343.42	324.51	343.42
Acenaphthylene	ug/kg	41,000	510	321.19	296.76	321.19
Dibenzofuran	ug/kg	6,200	450	347.07	329.55	347.07
Phenanthrene	ug/kg	50,000	1,700	388.17	341.47	388.17
Benzo(a)anthracene	ug/kg	220 or MDL	1,300	384.47	345.04	384.47
bis(2-Ethylhexyl)phthalate	ug/kg	50,000	780	403.23	374.18	403.23
Benzo(b)fluoranthene	ug/kg	1,100	740	361.06	335.18	361.06
benzo(k)fluoranthene	ug/kg	1,100	870	366.41	338.16	366.41
Benzo(a)pyrene	ug/kg	61 or MDL	1,500	392.92	350.29	392.92
Indeno(1,2,3-cd)pyrene	ug/kg	3,200	660	350.27	327.24	350.27
Dibenz(a,h)anthracene	ug/kg	14 or MDL	450	345.66	328.27	345.66
Benzo(g,h,i)perylene	ug/kg	50,000	880	360.20	334.95	360.20
Pesticides/PCBs						
Aroclor-1260	ug/kg	1,000	220	156.08	140.22	156.08
Metals						
Cadmium	mg/kg	1.74	8.2	2.59	2.25	2.59
Chromium	mg/kg	26.49	35	28.00	26.89	28.00
Copper	mg/kg	25	52.1	25.68	24.03	25.68
Lead	mg/kg	30	106	18.97	14.95	18.97
Zinc	mg/kg	88.89	1,710	131.27	130.15	131.27

CASE 4
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																Child(Nc)	Adult(Nc)	Car
Volatile Organics																		
Vinyl Chloride	9.8E-09		6.8E-09		2.9E-09	6.23E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dichloroethene, 1,2- (total)		5.3E-08		5.6E-09		4.12E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trichloroethene	8.0E-09		5.6E-09		2.4E-09	5.12E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Semi-volatiles																		
Methylnaphthalene, 2-						3.71E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Acenaphthylene						3.33E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzofuran						3.71E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene						4.96E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	7.6E-07		5.3E-07		2.3E-07	4.84E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
bis(2-Ethylhexyl)phthalate	6.7E-07	5.5E-06	4.7E-07	5.9E-07	2.0E-07	4.31E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	6.5E-07		4.6E-07		2.0E-07	4.16E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	6.8E-07		4.7E-07		2.0E-07	4.32E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	7.9E-07		5.6E-07		2.4E-07	5.08E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	6.0E-07		4.2E-07		1.8E-07	3.86E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	5.8E-07		4.0E-07		1.7E-07	3.67E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene						4.14E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCB's																		
Aroclor-1260	2.7E-07		1.9E-07		8.0E-08	1.70E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																		
Cadmium		3.6E-05		3.9E-06		2.85E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium VI		3.6E-04		3.9E-05		2.84E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper		3.9E-04		4.2E-05		3.03E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead						2.50E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc		1.8E-03		1.9E-04		1.42E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	**95th UCL Soil Data**
IR = Ingestion Rate (mg soil/day)	**100 (Adult)/ 200 (Child)**
CF = Conversion Factor (10-6 kg/mg)	**10-6**
FI = Fraction Ingested (unitless)	**1**
EF = Exposure Frequency (days/years)	**350 events/year**
ED = Exposure Duration (years)	**30 years**
BW = Bodyweight (kg)	**70 (Adult male)/ 15 (Child 6-7)**
AT = Averaging Time (days)	**6 x 365 Child 24 x 365 Adult (NC)** **70 x 365 (C)**

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
Volatile Organics									
Vinyl Chloride			9.8E-09	NA	1.9E+00				1.9E-08
Dichloroethene, 1,2- (total)	5.65E-09	5.3E-08		9.0E-03	NA	6.3E-07	5.9E-06	6.5E-06	
Trichloroethene			8.0E-09	NA	1.1E-02				8.8E-11
Semi-volatiles									
Methylnaphthalene, 2-				NA	NA				
Acenaphthylene				NA	NA				
Dibenzofuran				NA	NA				
Phenanthrene				NA	NA				
Benzo(a)anthracene			7.6E-07	NA	7.3E-01				5.5E-07
bis(2-Ethylhexyl)phthalate	5.90E-07	5.5E-06	6.7E-07	2.0E-02	1.4E-02	2.9E-05	2.8E-04	3.0E-04	9.4E-09
Benzo(b)fluoranthene			6.5E-07	NA	7.3E-01				4.8E-07
Benzo(k)fluoranthene			6.8E-07	NA	7.3E-02				4.9E-08
Benzo(a)pyrene			7.9E-07	NA	7.3E+00				5.8E-06
Indeno(1,2,3-cd)pyrene			6.0E-07	NA	7.3E-01				4.4E-07
Dibenzo(a,h)anthracene			5.8E-07	NA	7.3E+00				4.2E-06
Benzo(g,h,i)perylene				NA	NA				
Pesticides/PCB's									
Aroclor-1260			2.7E-07	NA	7.7E+00				2.0E-06
Metals									
Cadmium	3.91E-06	3.6E-05		5.0E-04	NA	7.8E-03	7.3E-02	8.1E-02	
Chromium VI	3.89E-05	3.6E-04		5.0E-03	NA	7.8E-03	7.3E-02	8.0E-02	
Copper	4.16E-05	3.9E-04		4.0E-02	NA	1.0E-03	9.7E-03	1.1E-02	
Lead				NA	NA				
Zinc	1.95E-04	1.8E-03		3.0E-01	NA	6.5E-04	6.1E-03	6.7E-03	
Totals - HQ & CR								**1.8E-01**	**1.4E-05**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		1.3E-09	6.30E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Dichloroethene, 1,2- (total)	4.3E-09		7.25E-03	100	1.0E-06	1	150	25	70	9,125	25,550
Trichloroethene		2.9E-09	1.36E-02	100	1.0E-06	1	150	25	70	9,125	25,550
Semi-volatiles											
Methylnaphthalene, 2-			3.43E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Acenaphthylene			3.21E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzofuran			3.47E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			3.88E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		8.1E-08	3.84E-01	100	1.0E-06	1	150	25	70	9,125	25,550
bis(2-Ethylhexyl)phthalate	2.4E-07	8.5E-08	4.03E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		7.6E-08	3.61E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		7.7E-08	3.66E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		8.2E-08	3.93E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		7.3E-08	3.50E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		7.2E-08	3.46E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			3.60E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Aroclor-1260		3.3E-08	1.56E-01	100	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Cadmium	1.5E-06		2.59E+00	100	1.0E-06	1	150	25	70	9,125	25,550
Chromium VI	1.6E-05		2.80E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Copper	1.5E-05		2.57E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Lead			1.90E+01	100	1.0E-06	1	150	25	70	9,125	25,550
Zinc	7.7E-05		1.31E+02	100	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: Intake (mg/kg-day) =

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	150 events/year
ED = Exposure Duration (years)	25 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

07/15/94

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.3E-09	NA	1.9E+00		2.5E-09
Dichloroethene, 1,2- (total)	4.3E-09		9.0E-03	NA	4.7E-07	
Trichloroethene		2.9E-09	NA	1.1E-02		3.1E-11
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		8.1E-08	NA	7.3E-01		5.9E-08
bis(2-Ethylhexyl)phthalate	2.4E-07	8.5E-08	2.0E-02	1.4E-02	1.2E-05	1.2E-09
Benzo(b)fluoranthene		7.6E-08	NA	7.3E-01		5.5E-08
Benzo(k)fluoranthene		7.7E-08	NA	7.3E-02		5.6E-09
Benzo(a)pyrene		8.2E-08	NA	7.3E+00		6.0E-07
Indeno(1,2,3-cd)pyrene		7.3E-08	NA	7.3E-01		5.4E-08
Dibenzo(a,h)anthracene		7.2E-08	NA	7.3E+00		5.3E-07
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		3.3E-08	NA	7.7E+00		2.5E-07
Metals						
Cadmium	1.5E-06		5.0E-04	NA	3.0E-03	
Chromium VI	1.6E-05		5.0E-03	NA	3.3E-03	
Copper	1.5E-05		4.0E-02	NA	3.8E-04	
Lead			NA	NA		
Zinc	7.7E-05		3.0E-01	NA	2.6E-04	
Totals - HQ & CR					**7.0E-03**	**1.6E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4
CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)
SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Volatile Organics											
Vinyl Chloride		1.0E-10	6.23E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Dichloroethene, 1,2- (total)	1.6E-10		4.12E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Trichloroethene		8.6E-11	5.12E-03	100	1.0E-06	1	10	30	70	10,950	25,550
Semi-volatiles											
Methylnaphthalene, 2-			3.71E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Acenaphthylene			3.33E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzofuran			3.71E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Phenanthrene			4.96E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)anthracene		8.1E-09	4.84E-01	100	1.0E-06	1	10	30	70	10,950	25,550
bis(2-Ethylhexyl)phthalate	1.7E-08	7.2E-09	4.31E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(b)fluoranthene		7.0E-09	4.16E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(k)fluoranthene		7.2E-09	4.32E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(a)pyrene		8.5E-09	5.08E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene		6.5E-09	3.86E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Dibenzo(a,h)anthracene		6.2E-09	3.67E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Benzo(g,h,i)perylene			4.14E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Pesticides/PCB's											
Aroclor-1260		2.8E-09	1.70E-01	100	1.0E-06	1	10	30	70	10,950	25,550
Metals											
Cadmium	1.1E-07		2.85E+00	100	1.0E-06	1	10	30	70	10,950	25,550
Chromium VI	1.1E-06		2.84E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Copper	1.2E-06		3.03E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Lead			2.50E+01	100	1.0E-06	1	10	30	70	10,950	25,550
Zinc	5.6E-06		1.42E+02	100	1.0E-06	1	10	30	70	10,950	25,550

Intake (mg/kg-day) =

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	10 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (DAILY) HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE) SENECA ARMY DEPOT ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		1.0E-10	NA	1.9E+00		2.0E-10
Dichloroethene, 1,2- (total)	1.6E-10		9.0E-03	NA	1.8E-08	
Trichloroethene		8.6E-11	NA	1.1E-02		9.5E-13
Semi-volatiles						
Methylnaphthalene, 2-			NA	NA		
Acenaphthylene			NA	NA		
Dibenzofuran			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		8.1E-09	NA	7.3E-01		5.9E-09
bis(2-Ethylhexyl)phthalate	1.7E-08	7.2E-09	2.0E-02	1.4E-02	8.4E-07	1.0E-10
Benzo(b)fluoranthene		7.0E-09	NA	7.3E-01		5.1E-09
Benzo(k)fluoranthene		7.2E-09	NA	7.3E-02		5.3E-10
Benzo(a)pyrene		8.5E-09	NA	7.3E+00		6.2E-08
Indeno(1,2,3-cd)pyrene		6.5E-09	NA	7.3E-01		4.7E-09
Dibenzo(a,h)anthracene		6.2E-09	NA	7.3E+00		4.5E-08
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCB's						
Aroclor-1260		2.8E-09	NA	7.7E+00		2.2E-08
Metals						
Cadmium	1.1E-07		5.0E-04	NA	2.2E-04	
Chromium VI	1.1E-06		5.0E-03	NA	2.2E-04	
Copper	1.2E-06		4.0E-02	NA	3.0E-05	
Lead			NA	NA		
Zinc	5.6E-06		3.0E-01	NA	1.9E-05	
Totals - HQ & CR					**4.9E-04**	**1.5E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4
CALCULATION OF ABSORBED DOSE (ONSITE) FROM DERMAL CONTACT TO SOIL (DAILY) HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		5.7E-09	1.70E-01	1.0E-06	2,000	1.0	0.1	10	30	70	10,950	25,550
Metals												
Cadmium	2.2E-08		2.85E+00	1.0E-06	2,000	1.0	0.01	10	30	70	10,950	25,550

EQUATION:

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
CF = Conversion Factor (10-6 kg/mg)	10-6
SA = Surface Area Contact (cm²)	2000 cm² (Adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1
ABS = Absorption Factor (unitless)	0.01

Variables:	Assumptions:
EF = Exposure Frequency (days/year)	10 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 kg (adult)
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 Adult (Car)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) HUNTER EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		5.7E-09	NA	8.1E+00		4.6E-08
Metals						
Cadmium	2.2E-08		3.0E-05	NA	7.4E-04	
Totals - HQ & CR					**7.4E-04**	**4.6E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4
CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics												
Semi-volatiles												
Pesticides/PCB's												
Aroclor-1260		1.8E-07	1.70E-01	1.0E-06	5,000	1.0	0.1	150	25	70	9,125	25,550
Metals												
Cadmium	8.4E-07		2.85E+00	1.0E-06	5,000	1.0	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data (all soils)	EF = Exposure Frequency (days/year)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm²)	5000(A)	BW = Bodyweight (kg)	70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1.00	AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)
ABS = Absorption Factor (unitless)	varies EPA, 1992		

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) CONSTRUCTION WORKER EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Semi-volatiles						
Pesticides/PCB's						
Aroclor-1260		1.8E-07	NA	8.1E+00		1.4E-06
Metals						
Cadmium	8.4E-07		3.0E-05	NA	2.8E-02	
Totals - HQ & CR					**2.8E-02**	**1.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4

CALCULATION OF ABSORBED DOSE (ONSITE) FROM DERMAL CONTACT TO SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm²)	Adult Skin Surface Area Contact (cm²)	Adherence Factor (mg soil/cm²)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Volatile Organics																			
Semi-volatiles																			
Pesticides/PCB's																			
Aroclor-1260	6.0E-07		2.0E-07		4.0E-07	1.70E-01	1.0E-06	2,165	5,000	1.0	0.1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Cadmium	0.0E+00	3.9E-06		2.0E-06		2.85E+00	1.0E-06	2,165	5,000	1.0	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**	**Variables:**	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm²)	2165(C)/5000(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm²)	1.00	AT = Averaging Time (days)	6 x 365 Child 24 x 365 Adult (Nc)
ABS = Absorption Factor (unitless)	varies EPA, 1992		70 x 365 (Car)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Adult CDI (Nc) (mg/kg-day)	Child CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	Dermal RfD (mg/kg-day)	Dermal Slope Factor (mg/kg-day)-1	Adult Hazard Quotient	Child Hazard Quotient	Hazard Quotient	Cancer Risk
<u>Volatile Organics</u>									
<u>Semi-volatiles</u>									
<u>Pesticides/PCB's</u>									
Aroclor-1260			6.0E-07	NA	8.1E+00				4.9E-06
<u>Metals</u>									
Cadmium	2.0E-06	3.9E-06	0.0E+00	3.0E-05	NA	6.5E-02	1.3E-01	2.0E-01	
Totals - HQ & CR								**2.0E-01**	**4.9E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4
SENECA ARMY DEPOT
ASH LANDFILL-HOT SPOT
SOIL ANALYSIS RESULTS
VALIDATED DATA (PHASES I & II)
POTENTIAL CHEMICALS OF CONCERN

COMPOUND	units	NYSDEC TAGM	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD.DEV	COEF OF VARIATION	NORMAL/ LOGNORMAL
Volatile Organics									
Vinyl Chloride	ug/kg		16	17	7.66	6.56	2.66	0.41	NORMAL
Chloroethane	ug/kg		0	NA	NA	NA	0.00	NA	NA
Acetone	ug/kg		16	8	6.67	6.34	0.79	0.12	NORMAL
Carbon Disulfide	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
1,1-Dichloroethene	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
1,2-Dichloroethene (total)	ug/kg		16	210	74.69	30.47	66.41	2.18	LOGNORMAL
Chloroform	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
1,2-Dichloroethane	ug/kg		16	21	7.98	6.28	4.12	0.66	NORMAL
2-Butanone	ug/kg		16	17	7.66	6.56	2.66	0.41	NORMAL
1,1,1-Trichloroethane	ug/kg		0	NA	NA	NA	0.00	NA	NA
Trichloroethene	ug/kg		16	540	191.78	63.25	137.17	2.17	LOGNORMAL
Benzene	ug/kg		3	3	3.11	2.83	0.29	0.10	NORMAL
Tetrachloroethene	ug/kg		3	3	3.11	2.83	0.29	0.10	NORMAL
Toluene	ug/kg		16	9	6.18	5.63	1.35	0.24	NORMAL
Chlorobenzene	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
Ethylbenzene	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL
Xylene (total)	ug/kg		16	9	6.11	5.50	1.49	0.27	NORMAL

CASE 4

CALCULATION OF VOLATILE ORGANIC COMPOUNDS IN AMBIENT AIR
RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

COMPOUND	Off-Site Conc. ug/m^3	On-Site Conc. ug/m^3	Average Emission Rate Ei g/s	Effective Diffusivity Dei cm^2/s	Molecular Diffusivity Di cm^2/s	Bulk Soil Concentration Ci g/g	Exposure Interval t sec.	Soil Porosity ε	Exposed Surface Area A cm^2	Constant a	Soil/Air Partition Coef. Kas g/cm^3
Volatile Organics											
Vinyl Chloride	0.006	0.027	9.3115E-06	0.074023	0.102103	7.6580E-09	9.10E+08	0.38	6.82E+07	2.98E-02	2.95
Chloroethane	NA	NA	NA	0.0718	0.099037	0.0000E+00	9.10E+08	0.38	6.82E+07	1.20E-03	0.07
Acetone	0.000	0.001	4.9685E-07	0.071065	0.098023	6.6686E-09	9.10E+08	0.38	6.82E+07	3.11E-04	0.02
Carbon Disulfide	0.002	0.007	2.4399E-06	0.076044	0.10489	6.1146E-09	9.10E+08	0.38	6.82E+07	7.34E-03	0.47
1,1-Dichloroethene	0.002	0.010	3.5668E-06	0.062898	0.086758	6.1146E-09	9.10E+08	0.38	6.82E+07	1.24E-02	1.07
1,2-Dichloroethene (total)	0.013	0.054	1.8465E-05	0.062898	0.086758	7.4692E-08	9.10E+08	0.38	6.82E+07	3.12E-03	0.23
Chloroform	0.001	0.003	1.1580E-06	0.068672	0.094722	6.1146E-09	9.10E+08	0.38	6.82E+07	1.91E-03	0.13
1,2-Dichloroethane	0.001	0.004	1.5311E-06	0.061481	0.084803	7.9768E-09	9.10E+08	0.38	6.82E+07	1.95E-03	0.14
2-Butanone	0.000	0.001	4.2855E-07	0.061749	0.085173	7.6580E-09	9.10E+08	0.38	6.82E+07	1.76E-04	0.01
1,1,1-Trichloroethane	0.000	0.000	0.0000E+00	0.055018	0.075889	0.0000E+00	9.10E+08	0.38	6.82E+07	2.34E-03	0.19
Trichloroethene	0.025	0.104	3.5755E-05	0.056046	0.077306	1.9178E-07	9.10E+08	0.38	6.82E+07	1.84E-03	0.15
Benzene	0.000	0.002	5.7884E-07	0.06013	0.08294	3.1075E-09	9.10E+08	0.38	6.82E+07	1.84E-03	0.14
Tetrachloroethene	0.000	0.002	5.4945E-07	0.051194	0.070614	3.1075E-09	9.10E+08	0.38	6.82E+07	1.65E-03	0.15
Toluene	0.000	0.002	6.0664E-07	0.054111	0.074637	6.1793E-09	9.10E+08	0.38	6.82E+07	5.33E-04	0.04
Chlorobenzene	0.000	0.001	4.3401E-07	0.053528	0.073833	6.1146E-09	9.10E+08	0.38	6.82E+07	2.81E-04	0.02
Ethylbenzene	0.000	0.001	3.0036E-07	0.049563	0.068364	6.1146E-09	9.10E+08	0.38	6.82E+07	1.35E-04	0.01
Xylene (total)	0.000	0.002	6.7652E-07	0.049563	0.068364	6.1146E-09	9.10E+08	0.38	6.82E+07	6.72E-04	0.06

CASE 4

CALCULATION OF INTAKE (OFF-SITE)
FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR
RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	**Intake (Nc)** (mg/kg-day)	**Intake (Car)** (mg/kg-day)	**95th UCL Air** (ug/m^3)	**Inhalation Rate** (m^3/day)	**Exposure Frequency** (days/year)	**Exposure Duration** (years)	**Body Weight** (kg)	**Averaging Time** (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		7.6E-07	6.43E-03	20	350	30	70	10,950	25,550
Chloroethane			NA	20	350	30	70	10,950	25,550
Acetone			3.43E-04	20	350	30	70	10,950	25,550
Carbon Disulfide	4.6E-07		1.69E-03	20	350	30	70	10,950	25,550
1,1-Dichloroethene		2.9E-07	2.46E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	3.5E-06		1.28E-02	20	350	30	70	10,950	25,550
Chloroform		9.4E-08	8.00E-04	20	350	30	70	10,950	25,550
1,2-Dichloroethane	2.9E-07	1.2E-07	1.06E-03	20	350	30	70	10,950	25,550
2-Butanone	8.1E-08		2.96E-04	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		2.9E-06	2.47E-02	20	350	30	70	10,950	25,550
Benzene		4.7E-08	4.00E-04	20	350	30	70	10,950	25,550
Tetrachloroethene		4.5E-08	3.80E-04	20	350	30	70	10,950	25,550
Toluene	1.1E-07		4.19E-04	20	350	30	70	10,950	25,550
Chlorobenzene	8.2E-08		3.00E-04	20	350	30	70	10,950	25,550
Ethylbenzene	5.7E-08		2.08E-04	20	350	30	70	10,950	25,550
Xylene (total)			4.67E-04	20	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m^3)	95th UCL Air Model Data
IR = Inhalation Rate (m^3/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		7.6E-07	NA	2.9E-01		2.2E-07
Chloroethane			2.9E+00	NA		
Acetone			NA	NA		
Carbon Disulfide	4.6E-07		2.9E-03	NA	1.6E-04	
1,1-Dichloroethene		2.9E-07	NA	1.8E-01		5.1E-08
1,2-Dichloroethene (total)	3.5E-06		1.2E+00	NA	2.9E-06	
Chloroform		9.4E-08	NA	8.1E-02		7.6E-09
1,2-Dichloroethane	2.9E-07	1.2E-07	2.9E-03	9.1E-02	1.0E-04	1.1E-08
2-Butanone	8.1E-08		2.9E-01	NA	2.8E-07	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		2.9E-06	NA	6.0E-03		1.7E-08
Benzene		4.7E-08	NA	2.9E-02		1.4E-09
Tetrachloroethene		4.5E-08	NA	2.0E-03		8.9E-11
Toluene	1.1E-07		1.1E-01	NA	1.0E-06	
Chlorobenzene	8.2E-08		5.0E-03	NA	1.6E-05	
Ethylbenzene	5.7E-08		2.9E-01	NA	2.0E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**2.8E-04**	**3.1E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 4

CALCULATION OF INTAKE (ONSITE) FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT ASH LANDFILL

Analyte	**Intake (Nc)** (mg/kg-day)	**Intake (Car)** (mg/kg-day)	**95th UCL Air** (ug/m³)	**Inhalation Rate** (m³/day)	**Exposure Frequency** (days/year)	**Exposure Duration** (years)	**Body Weight** (kg)	**Averaging Time** (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		3.2E-06	2.71E-02	20	350	30	70	10,950	25,550
Chloroethane			NA	20	350	30	70	10,950	25,550
Acetone			1.45E-03	20	350	30	70	10,950	25,550
Carbon Disulfide	1.9E-06		7.11E-03	20	350	30	70	10,950	25,550
1,1-Dichloroethene		1.2E-06	1.04E-02	20	350	30	70	10,950	25,550
1,2-Dichloroethene (total)	1.5E-05		5.38E-02	20	350	30	70	10,950	25,550
Chloroform		4.0E-07	3.37E-03	20	350	30	70	10,950	25,550
1,2-Dichloroethane	1.2E-06	5.2E-07	4.46E-03	20	350	30	70	10,950	25,550
2-Butanone	3.4E-07		1.25E-03	20	350	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	20	350	30	70	10,950	25,550
Trichloroethene		1.2E-05	1.04E-01	20	350	30	70	10,950	25,550
Benzene		2.0E-07	1.69E-03	20	350	30	70	10,950	25,550
Tetrachloroethene		1.9E-07	1.60E-03	20	350	30	70	10,950	25,550
Toluene	4.8E-07		1.77E-03	20	350	30	70	10,950	25,550
Chlorobenzene	3.5E-07		1.26E-03	20	350	30	70	10,950	25,550
Ethylbenzene	2.4E-07		8.75E-04	20	350	30	70	10,950	25,550
Xylene (total)			1.97E-03	20	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

07/15/94

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		3.2E-06	NA	2.9E-01		9.4E-07
Chloroethane			2.9E+00	NA		
Acetone			NA	NA		
Carbon Disulfide	1.9E-06		2.9E-03	NA	6.8E-04	
1,1-Dichloroethene		1.2E-06	NA	1.8E-01		2.1E-07
1,2-Dichloroethene (total)	1.5E-05		1.2E+00	NA	1.2E-05	
Chloroform		4.0E-07	NA	8.1E-02		3.2E-08
1,2-Dichloroethane	1.2E-06	5.2E-07	2.9E-03	9.1E-02	4.2E-04	4.8E-08
2-Butanone	3.4E-07		2.9E-01	NA	1.2E-06	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		1.2E-05	NA	6.0E-03		7.3E-08
Benzene		2.0E-07	NA	2.9E-02		5.8E-09
Tetrachloroethene		1.9E-07	NA	2.0E-03		3.8E-10
Toluene	4.8E-07		1.1E-01	NA	4.2E-06	
Chlorobenzene	3.5E-07		5.0E-03	NA	6.9E-05	
Ethylbenzene	2.4E-07		2.9E-01	NA	8.4E-07	
Xylene (total)			NA	NA		
Total HQ & CR					**1.2E-03**	**1.3E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 4

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR
HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Air (ug/m³)	Inhalation Rate (m³/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Vinyl Chloride		3.6E-08	2.71E-02	8	10	30	70	10,950	25,550
Chloroethane	0.0E+00		NA	8	10	30	70	10,950	25,550
Acetone			1.45E-03	8	10	30	70	10,950	25,550
Carbon Disulfide	2.2E-08		7.11E-03	8	10	30	70	10,950	25,550
1,1-Dichloroethene		1.4E-08	1.04E-02	8	10	30	70	10,950	25,550
1,2-Dichloroethene (total)	1.7E-07		5.38E-02	8	10	30	70	10,950	25,550
Chloroform		4.5E-09	3.37E-03	8	10	30	70	10,950	25,550
1,2-Dichloroethane	1.4E-08	6.0E-09	4.46E-03	8	10	30	70	10,950	25,550
2-Butanone	3.9E-09		1.25E-03	8	10	30	70	10,950	25,550
1,1,1-Trichloroethane			0.00E+00	8	10	30	70	10,950	25,550
Trichloroethene		1.4E-07	1.04E-01	8	10	30	70	10,950	25,550
Benzene		2.3E-09	1.69E-03	8	10	30	70	10,950	25,550
Tetrachloroethene		2.1E-09	1.60E-03	8	10	30	70	10,950	25,550
Toluene	5.5E-09		1.77E-03	8	10	30	70	10,950	25,550
Chlorobenzene	4.0E-09		1.26E-03	8	10	30	70	10,950	25,550
Ethylbenzene	2.7E-09		8.75E-04	8	10	30	70	10,950	25,550
Xylene (total)			1.97E-03	8	10	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m³)	95th UCL Air Model Data
IR = Inhalation Rate (m³/day)	8
EF = Exposure Frequency (days/yr)	10
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF VOLATILE ORGANICS IN AMBIENT AIR HUNTER EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
ASH LANDFILL

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Vinyl Chloride		3.6E-08	NA	2.9E-01		1.1E-08
Chloroethane	0.0E+00		2.9E+00	NA	0.0E+00	
Acetone			NA	NA		
Carbon Disulfide	2.2E-08		2.9E-03	NA	7.8E-06	
1,1-Dichloroethene		1.4E-08	NA	1.8E-01		2.4E-09
1,2-Dichloroethene (total)	1.7E-07		1.2E+00	NA	1.4E-07	
Chloroform		4.5E-09	NA	8.1E-02		3.6E-10
1,2-Dichloroethane	1.4E-08	6.0E-09	2.9E-03	9.1E-02	4.8E-06	5.4E-10
2-Butanone	3.9E-09		2.9E-01	NA	1.4E-08	
1,1,1-Trichloroethane			NA	NA		
Trichloroethene		1.4E-07	NA	6.0E-03		8.4E-10
Benzene		2.3E-09	NA	2.9E-02		6.6E-11
Tetrachloroethene		2.1E-09	NA	2.0E-03		4.3E-12
Toluene	5.5E-09		1.1E-01	NA	4.8E-08	
Chlorobenzene	4.0E-09		5.0E-03	NA	7.9E-07	
Ethylbenzene	2.7E-09		2.9E-01	NA	9.6E-09	
Xylene (total)			NA	NA		
Total HQ & CR					**1.4E-05**	**1.5E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor