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Environmental Restoration Program

OPERABLE UNIT 1
FEASIBILITY STUDY REPORT

MOUND PLANT
MIAMISBURG, OHIO

October 1994

Final
(Revision 0)

U.S. Department of Energy
Albuquerque Operations Office

EG&G Mound Applied Technologies

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EG&G MOUND APPLIED TECHNOLOGIES

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ACRONYMS

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
COPC	contaminants of potential concern
CORA	Cost of Remedial Action (model)
CTE	central tendency exposure
D&D	Decontamination and Decommissioning
DCE	dichloroethene
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration (Program)
FFA	Federal Facility Agreement
FML	flexible membrane liner
FS	Feasibility Study
IRF	*in situ* radio frequency
MCL	maximum contaminant level
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OEPA	Ohio Environmental Protection Agency
PA	preliminary assessment
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRG	preliminary remediation goal
RA	remedial action
RAPCA	Regional Air Pollution Control Agency
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RI	remedial investigation
RIR	Remedial Investigation Report
RME	reasonable maximum exposure
SARA	Superfund Amendments and Reauthorization Act
SI	site inspection
TCA	trichlorethane
TCE	trichloroethene
UV	ultraviolet
VOC	volatile organic compound

UNITS OF MEASURE

cm/s	centimeters per second
cu ft	cubic feet
ft	feet
gpm	gallons per minute
MeV	Mega electron volts
mm	millimeters
nCi/l	nanocuries per liter

pCi/G	picocuries per gram
sq ft	square feet
yr	year
μg/l	microgram per liter

1. INTRODUCTION

Mound Plant was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (also known as Superfund) National Priority List on 21 November 1989. Pursuant to its National Priority List status, the U.S. Department of Energy (DOE) signed a CERCLA Section 120 Federal Facility Agreement (FFA) with the U.S. Environmental Protection Agency (EPA), which became effective 11 October 1990 (EPA 1990a). A similar tripartite agreement was signed among the DOE, EPA, and Ohio Environmental Protection Agency (OEPA) in July 1993 (EPA 1993a).

The Environmental Restoration (ER) Program, which consists of three phases, is patterned after the EPA CERCLA program. Phase I, preliminary assessment/site inspection (PA/SI), was completed at Mound Plant in 1986. Phase II, a remedial investigation/feasibility study (RI/FS), is currently under way at Mound Plant. Phase III, remedial design/remedial action (RD/RA), will implement the remedial alternatives chosen in the feasibility studies of Phase II. Figure 1.1 shows the three phases and the components, or tasks, included in each phase. These tasks have been identified by the EPA to describe the activities performed during the PA/SI, RI/FS, and RD/RA phases of the CERCLA process.

DOE Order 5400.4 requires integration of CERCLA/Resource Conservation and Recovery Act (RCRA) with the National Environmental Policy Act (NEPA), and states that integration will be achieved through the RI/FS documents. This means that RI/FS reports are modified to meet both the RI/FS and NEPA requirements.

Mound Plant is divided into six operable units based on geography and contaminant occurrence. Operable Units 1, 2, 4, 5, 6, and 9 divide the Mound Plant Site into general geographic areas (Figure 1.2). The elements of the ER Program and the RI/FS process for each operable unit will address all media sources and contaminants within its assigned boundaries.

The RI/FS process represents the methodology that the Superfund program has established for characterizing the nature and extent of risks posed by uncontrolled hazardous waste sites (the RI) and for evaluating potential remedial options (the FS). The content of the RI/FS process is prescribed in OSWER Directive 9355.3-01, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). It is further specified in Section X and Attachment I of the FFA (EPA 1990a).

1.1. PURPOSE AND ORGANIZATION OF THE REPORT

The purpose of this report is to present the results of the Operable Unit 1, Area B, feasibility study. It incorporates and builds on the findings of the RI report (DOE 1994a). The organization of the report

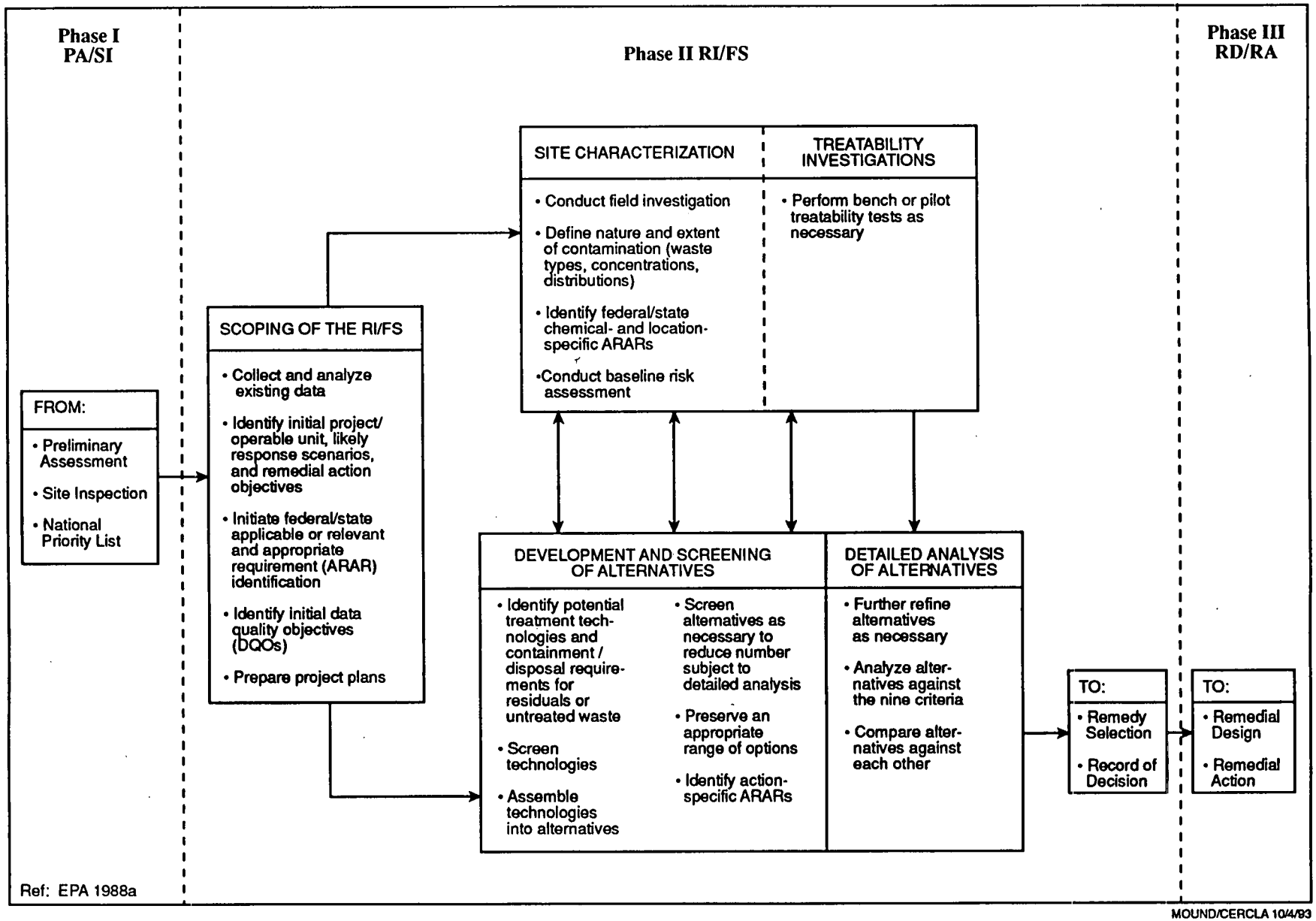
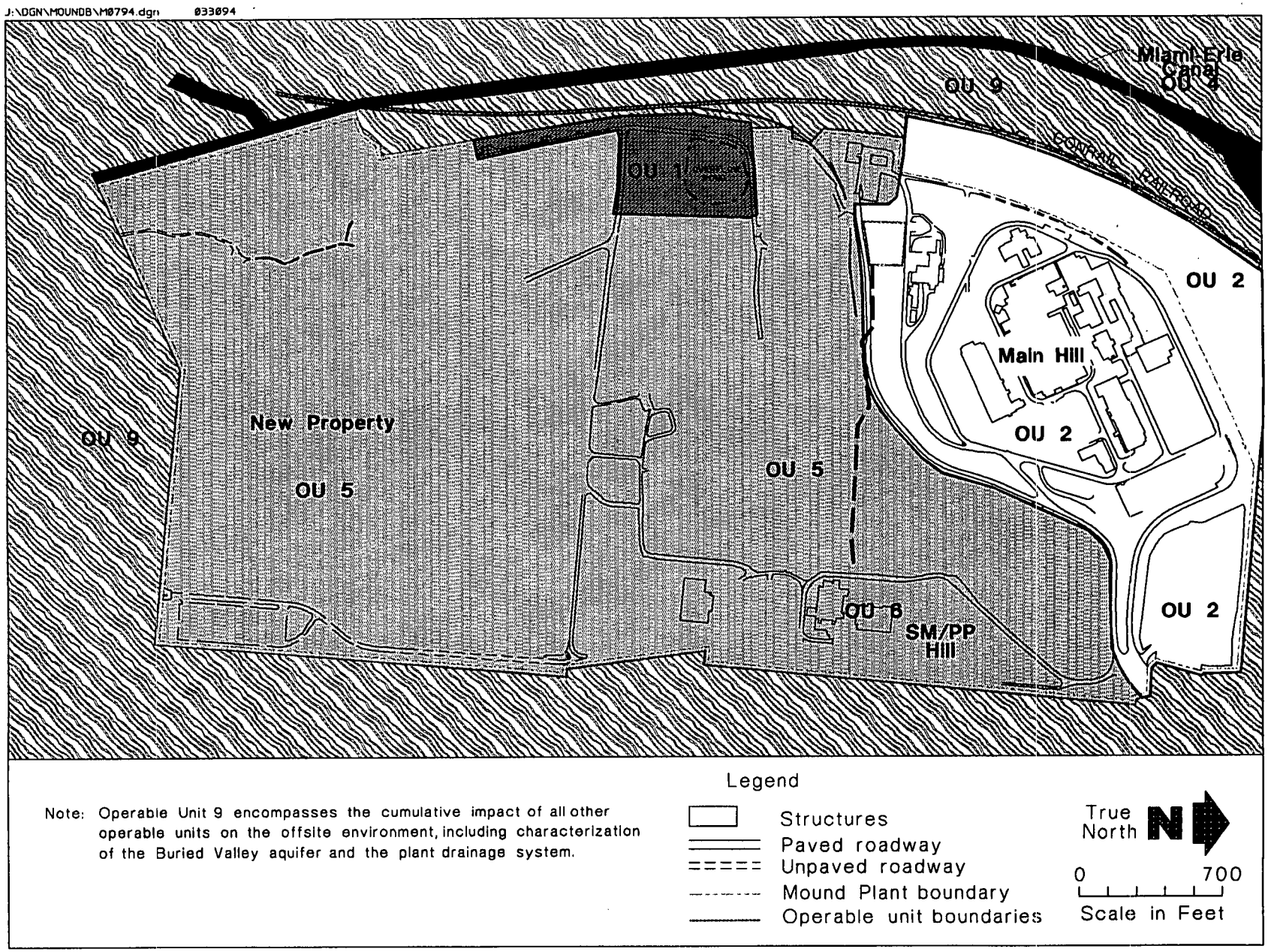


Figure 1.1. Phases of the CERCLA process.



Note: Operable Unit 9 encompasses the cumulative impact of all other operable units on the offsite environment, including characterization of the Buried Valley aquifer and the plant drainage system.

Figure 1.2. Mound plant operable unit boundaries.

follows the suggested FS report format (Table 6-5 in the EPA guidance document) (EPA 1988). Appendix A to this document contains the current determination of applicable or relevant and appropriate requirements (ARARs). Appendix B contains the calculations for estimating the area and volume of contaminated media. Appendix C contains a description of the process options. Appendix D contains capital and first-year operation and maintenance (O&M) cost estimates. Appendix E contains recovery well capture zone modeling. Appendix F contains a detailed analysis of the cost estimates.

1.2. BACKGROUND

Area B, Operable Unit 1, occupies approximately 4 acres in the southwestern portion of the Mound Plant. It encompasses four areas: the historic landfill, the site sanitary landfill, the overflow pond, and the three plant production wells. Mound Plant used the historic landfill site from 1948 to 1974. Waste materials that were disposed of, some by burning, in Area B included general trash, liquid wastes, and low-level radioactive wastes. Much of this waste was relocated to and encapsulated in a site sanitary landfill constructed in 1977. An overflow pond was constructed simultaneously, partially covering the historic landfill site. After 1977, waste was no longer disposed of in Area B. Area B was recently extended to include the three plant production wells located along the southern plant boundary. An extended discussion of Area B history, including waste disposal and construction activities, is provided in the RI Report (DOE 1994a).

The former waste disposal sites within Area B (the historic landfill and associated features) are concentrated within, beneath, and immediately adjacent to the current site sanitary landfill. These waste disposal sites are the result of a long history of dumping, burning, moving, reworking, burying, and partially removing wastes and placing them into the engineered structure (the site sanitary landfill). Currently, the area bounded by the overflow pond to the north, the paved roads to the west and south, and the bunker area to the east can be considered a single entity. It is internally heterogeneous and not all portions are contaminated; however, subdividing the area does not increase understanding of the transport phenomena that are occurring, nor does it facilitate developing remedial alternatives for the area.

1.3. CURRENT AND PREVIOUS INVESTIGATIONS SUMMARY

Mound Plant personnel began a periodic water sampling program for volatile organic compounds (VOCs) in 1984. Under the ER Program, the RI began in 1987, focusing on observations of groundwater contamination. Since 1986, VOCs have been detected and monitored in the groundwater (DOE 1992a). To date, three formal stages of the RI have been completed, followed by a program of additional field work.

In addition to the Operable Unit 1 installations, monitoring wells and piezometers were installed as part of the Operable Unit 9, Site-Wide RI. Specifications of these wells and piezometers are provided in the *Operable Unit 9, Hydrogeologic Investigation Well Information Report* (DOE 1994b). Installations in the vicinity of Area B are shown on Figure 1.3, which also depicts the areas of groundwater impacted by VOCs, as discussed below.

Groundwater Sampling

Groundwater quality data indicate the following:

- VOCs present with validated detections include 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1,-dichloroethene, 1,2,-*cis*-dichloroethene, 1,2-*trans*-dichloroethene, 1,2-dichloroethene (total), brodichloromethane, vinyl chloride (chloroethene), dichloromethane, methylene chloride, dibromochloromethane, tetrachloroethene (PCE), tetrachloromethane (carbon tetrachloride), total xylenes, trichloroethene (TCE), trichloromethane (chloroform), freon-113®, and trichlorofluoromethane.

- Metals present with validated detections include aluminum, antimony, arsenic, barium, cadmium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, vanadium, and zinc.

In January 1990, tritium was detected in Area B monitoring wells 306 and 310 at concentrations of 12.6 and 14.2 nanocuries per liter (nCi/L), respectively. These wells are west of the site sanitary landfill (Figure 1.3). Data from September 1992 and March 1993 confirm that tritium still exists in the groundwater in and adjacent to Area B; however, these concentrations (ranging from 1.4 to 10.6 nCi/L) are below the drinking water standard of 20 nCi/L (40 CFR 141).

Continued quarterly sampling has not revealed a significantly altered pattern of contamination. Because conditions at the site have not altered significantly since the mid-1970s, a relatively steady state regime has been established.

Radiological Sampling

From 1982 to 1985, Mound Plant collected radiologic data on the sanitary landfill cap (previously described as Area 18). Samples were also collected from the vicinity of an area used for disposing crushed empty thorium drums and polonium-210-contaminated sand. The results of the sampling are reported in the *Site Scoping Report: Volume 3 - Radiological Site Survey* (DOE 1993). The data gathered indicated widespread, low-level plutonium-238 surface soil contamination. Except for one subsurface sample (17.1 pCi/g), all concentrations within Area B were within the range of <1 to

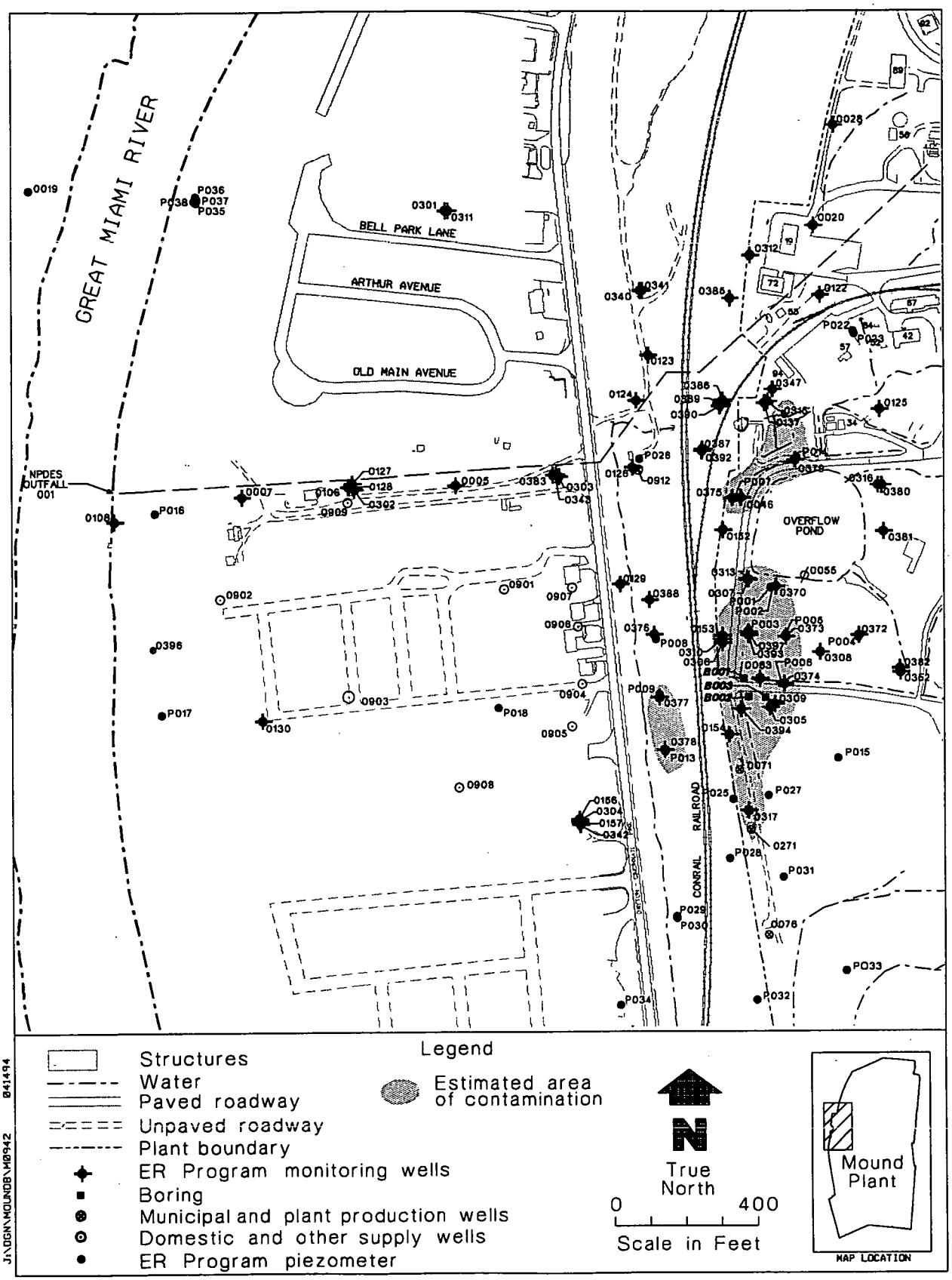


Figure 1.3. Location of ER Program exploration borings, piezometers, monitoring wells, and areas of groundwater impacted by volatile organic contamination.

approximately 4 pCi/g. Surface soil sampling, part of the additional field work, confirms these findings. With the exception of one sample (taken at the southeastern corner of Area B) with a plutonium level of 8.75 pCi/g, all samples were less than 4 pCi/g. All of these observations are well below the Mound Decontamination and Decommissioning (D&D) program as low as reasonably achievable (ALARA) goal of 25 pCi/g.

1.4. CONCEPTUAL MODEL

The conceptual model for Area B can be presented in terms of its geologic setting, hydrologic setting, contaminant occurrence, and immediate receptors.

Geologic Setting

Area B is partially located on a buried bedrock shelf that drops off to the west, north, and south (Plate B, DOE 1994a). The surface of the bedrock is a pre-glacial erosional surface that is weathered, but grades rapidly into competent material. The bedrock section subjacent to Area B is dominated by shale with a significant limestone-bearing portion truncated by erosion immediately beneath the site sanitary landfill. The next nearest (vertically) significant limestone portion is approximately 30 feet (ft) lower in the section and does not intersect the bedrock interface until some distance to the west of Area B, at or beyond the plant boundary. This means that the opportunity for contaminant transport from Area B through limestone layers is nonexistent.

The bedrock is overlain by glacial outwash materials, glacial till, and artificial fill. The outwash materials that contain the Buried Valley aquifer thin eastward against the buried valley margin, which is beneath the western edge of Area B adjacent to the waste disposal areas (site sanitary landfill, historic landfill). Only the western portion of the site sanitary landfill overlies the Buried Valley aquifer. The eastern portion overlies the bedrock shelf. To the north, these outwash materials extend up the plant tributary valley, as shown on cross section A-A[7] (Plate A, DOE 1994a). The portion of the Buried Valley aquifer immediately adjacent to Area B (to the west) varies from 0 to 40 ft thick and is relatively free of fine-grained till layers within the outwash. Typical transmissivities are between 30,000 and 50,000 ft^2/day. The aquifer is not composed of an upper and lower unit, as was supposed.

Hydrologic Setting

Groundwater occurs primarily in the outwash sediments of the Buried Valley aquifer or in its extension up the plant tributary valley. Within the tributary valley, gradients are steep and governed by topography and the thickness of the unconsolidated zone; flow is west-southwest along the valley axis.

In the main part of the Buried Valley aquifer, to the west of Area B, gradients are nearly flat; flow is west and south, governed by the interrelationships among recharge, river stage, and the pumping of the Mound Plant production wells. In the immediate vicinity of Area B, flow is governed by the plant production wells and is southward toward the then-pumping well.

The waste materials and contaminated soils within Area B are partially isolated from the hydrologic environment. Much of the surface is engineered to provide rapid runoff. The materials immediately below the waste disposal area are dominantly fine-grained. The water table is at or below the bedrock interface in this area, so the unconsolidated materials are also in the vadose zone. However, during periods of high seasonal groundwater (or enhanced recharge through the site), some waste materials or contaminated soil are exposed to circulating waters.

Contaminant Occurrence

Soils

VOCs were represented in subsurface soil analyses by 1,2-dichloroethene, ethylbenzene, tetrachloroethene, toluene, total xylenes, and trichloroethene. None of the surface soil samples had detectable quantities of VOCs. Examination of the areal extent of the VOC contamination in the soils shows that the contamination is restricted to the area of past disposal activity in Area B, with no discernible source. The majority of the concentration detections occurs at a depth of less than 20 ft and is limited in areal extent. Aroclor-1248, a polychlorinated biphenyl (PCB), was detected in both the surface and subsurface soil samples at 14 locations within Area B.

Tritium was detected at low levels throughout Area B. Radionuclides identified as contaminants of concern were plutonium-238 and strontium-90. Plutonium-239/240, thorium-230, uranium-234, and uranium-235/236 were also detected. The only discernible pattern in the radionuclide contamination was that all detections are in the site sanitary landfill area or along the drainage ditches.

The only discernible pattern for all the compounds detected during the surficial and subsurface soil sampling appear directly related to activities in and around the site sanitary landfill. There does not appear to be a major source of the contaminants detected, but rather a random pattern of dispersed contamination resulting from reworking and transporting of materials.

Groundwater

The recent groundwater sampling data (for June 1992 through March 1993) identified five VOCs in the groundwater beneath Area B at levels above proposed or established regulatory limits. These contaminants include vinyl chloride, trichloromethane, 1,2-*cis*-dichloroethene, trichloroethene, and tetrachloroethene. Only 1,1,1-trichloroethane shows concentrations offsite; the pattern of occurrence suggests a source outside Area B. These are generally less than 1 μg/L and appear to vary seasonally. There is no consistent trend in concentrations with time in wells in the area. Also, there appears to be little trend in contamination with depth. Thus, the data do not show a discernible pattern or a particular area where a potential source might exist, although the detections appear to be concentrated in the site sanitary landfill area and the assumed location of the historic landfill.

A review of the VOC analytical data taken since 1991 shows no major change in the concentrations measured in wells in Area B. Concentrations appear to fluctuate seasonally, possibly caused by changes in the recharge source with time. Another source is from flushing unsaturated sediments by higher water levels. It is likely that pumping well 0076 for the plant water supply also affects the concentration of VOCs within the groundwater and the potential for movement offsite by acting as a discharge point for groundwater. The probable explanation for the distribution of contaminants measured within Area B is a combination of the above factors.

Two metals (chromium and nickel were detected above primary drinking water standards from December 1991 to March 1993. Aluminum, iron, and manganese were detected above secondary drinking water standards during this same time period. There is no consistent trend in the concentrations in the area; however, the detections appear to be concentrated in the immediate site sanitary landfill area. Further, there is reason to believe that the elevated metals may be associated with sediments produced from the monitor wells. At this time, validated data are not available; however, for all the wells in question, filtered samples show nondetect for chromium. If subsequent sampling reveals a metals problem, DOE will notify the regulators and take appropriate action.

Migration Rate and Direction

Flow velocities (migration rates) for representative contaminants were calculated for the Buried Valley aquifer in the vicinity of Area B, assuming a uniform aquifer seepage velocity of 200 feet per year (ft/yr). Contaminants were chosen to illustrate a range of possible effects of retardation. Dichloroethene is retarded the least, with a possible velocity of 50 ft/yr. Trichloromethane and trichloroethene are retarded more (41 and 20 ft/yr, respectively). However, all VOCs tend to remain in the groundwater and do <u>not</u> partition appreciably back onto the soil. Thus, once in the groundwater

system, they would tend to move with the groundwater and not at the retarded velocities shown here. Thus, the actual rate of contaminant movement is expected to be somewhere between that of the groundwater and the retarded velocities shown above. Tritium is also expected to move at the same velocity as the groundwater; plutonium is not expected to move from contaminated soils (DOE 1994a).

Once a contaminant reaches the Buried Valley aquifer, it has the potential to move offsite quickly. However, these velocities assume there is no pumping within the Buried Valley aquifer. Analysis of groundwater flow patterns indicates that the pumping at well 0076 for the Mound Plant water supply creates a capture zone for at least a portion of the contamination within the Buried Valley aquifer adjacent to Area B.

Immediate Points of Exposure

The most immediate point of exposure for contaminants originating in Area B also lies within the confines of Operable Unit 1—the system of plant production wells. Production well 1 (0071) was taken off-line due to increasing levels of VOCs in the discharge water. Production well 3 (0076) is now the primary source of process and potable water for the plant. Well 2 (0271) is pumped as required to provide a supplemental source of plant water.

1.5. BASELINE RISK ASSESSMENT

The baseline risk assessment for Area B, Operable Unit 1, addresses future public health risks, assuming that no remedial actions will be performed. Therefore, the assessment serves as a baseline case to compare the relative effectiveness of alternative remedial strategies in reducing public health risks. This baseline risk assessment focuses on exposure of hypothetical future residents and site workers to soil and groundwater contamination. Any risk associated with a selected remedial action, such as landfill excavation, is not addressed as part of the baseline risk assessment, but will be addressed under adverse impacts in the FS.

This assessment involves 1) the determination of contaminant concentrations at exposure points for a future resident farmer scenario and future indoor and outdoor industrial park worker scenarios, and 2) the estimation of contaminant intake through potential exposure pathways. The future resident farmer scenario is generally the most conservative situation. However, when the pathways that apply only to the resident farmer are removed, the resultant risk is decreased by less than 0.5% for carcinogens and less than 0.1% for noncarcinogens. The additional pathways for the resident farmer over the resident include ingestion of homegrown dairy products and meat, and inhalation of soil particulates during farming activities.

The developed scenarios are conservative and hypothetical, and their relative risks can be interpreted more flexibly by examining the assumptions and conservation inherent in the calculations. The FS (which will address a future resident, not resident farmer as discussed in Section 2) will take advantage of this flexibility.

For the contaminants with the greatest risk contribution, the carcinogenic and noncarcinogenic risks for these two exposure scenarios (both reasonable maximum exposure (RME) and central tendency exposure (CTE)) are provided on Table I.1, along with a summary of risk. Ingestion/inhalation contribute to almost all of the risk; groundwater is the most important exposure medium (90 to 100 percent of each category). Tetrachloroethene had the highest overall carcinogenic risk in each exposure scenario; tetrachloromethane had the highest noncarcinogenic hazard index (80 to 90 percent of the contribution in each category). Because groundwater would contribute most of the carcinogenic and noncarcinogenic risks to future onsite residents or workers, groundwater must be the focus of the remedial efforts to significantly reduce the overall risk.

The baseline risk assessment is considered conservative and presents the RME and CTE scenarios in the absence of any remedial action. The general conclusion of the baseline risk assessment is that the contamination measured within Area B, Operable Unit 1, may represent a significant risk to future residents or workers on the site.

1.6. FUTURE USE SCENARIOS

Identified future uses for Area B will guide both the remedies to be considered and the performance standards against which contemplated remedies are measured. As with the Plant site as a whole, the future land use is "industrial." Thus, the exposed individual is an onsite worker, either inside or outside. The future indoor worker will have an 8-hour per day, 40-hour per week job inside a building erected at Area B. The outside worker is also exposed to contaminants exposed at the land surface. Either worker is expected to hold the job for 25 years. The potential risks to that worker are evaluated in Section 2.

In the case of the groundwater pathway, no exposure from a contaminant source within the Area B waste disposal area is predicted. Therefore, the residual risk posed by contaminant transport through the groundwater pathway will be assessed at the edge of the waste management area in Area B. The exposed individual, a full-time, life-long resident, will not be exposed to groundwater from within the Area B waste management area. The on-property worker is exposed to the groundwater source from within Area B waste disposal area for the 8 hour work day. In contrast to the resident farmer scenario used in the baseline risk assessment, exposure from livestock raised within Area B, will not be considered for the on-property worker or the life-long resident. The potential risks to the resident groundwater user are evaluated in Section 2, as well.

Table I.1. Summary of Risk and Contaminants with Greatest Risk Contribution (DOE 1994a)

	Overall Risk		Percent of Exposure Due to Ingestion and Inhalation	Percent of Risk via Groundwater Pathways	Contaminants of Concern with Greatest Effect	COC Effect	
	RME	CTE				RME	CTE
Carcinogenic Risk							
Resident Farmer or Resident[a]			83	96	Tetrachloroethene	2×10^{-4} (Adult + Child)	6×10^{-5} (Adult + Child)
Adult	5×10^{-4}	1×10^{-4}			Trichloromethane	1×10^{-4} (Adult + Child)	4×10^{-5} (Adult + Child)
Child	1×10^{-4}	3×10^{-5}					
Industrial Worker (Indoor)	2×10^{-4}	5×10^{-5}	80	100	Tetrachloroethene	8×10^{-5}	2×10^{-5}
					Trichloromethane	7×10^{-5}	2×10^{-5}
Industrial Worker (Outdoor)	1×10^{-4}	2×10^{-5}	83 (Inhalation and Dermal)	95	Tetrachloroethene	7×10^{-5}	1×10^{-5}
Noncarcinogenic HI							
Resident Farmer or Resident[b]			96	100	Tetrachloromethane	31 (Adult + Child)	20 (Adult + Child)
Adult	17	11					
Child	19	12					
Industrial Worker (Indoor)	16	10	98	100	Tetrachloromethane	15	10
Industrial Worker (Outdoor)	15	9	95 (Inhalation)	100	Tetrachloromethane	14	9

[a]Although the resident farmer scenario includes more exposure pathways than the resident, these pathways collectively contribute less than 0.5% additional risk for carcinogens.
[b]Additional pathways for resident farmer collectively contribute less than 0.1% additional risk for noncarcinogens.

COC - contaminant of concern
CTE - central tendency exposure
HI - hazard index
RME - reasonable maximum exposure

The Feasibility Study Process

Using the EPA guidance (EPA 1988), the FS may be viewed (for explanatory purposes) as occurring in three phases: the development of alternatives, the screening of alternatives, and the detailed analysis of alternatives. The alternatives are developed by assembling combinations of technologies.

The first step is the identification and screening of the universe of potentially applicable technologies to eliminate those that cannot be implemented technically at the site (subsection 2.3.1 of the FS). This is done according to site-specific and waste-specific information. To simplify the development process, the applicable technologies are then evaluated in greater detail to select one representative process option for each technology type (subsection 2.3.2 of the FS). This evaluation is based on the same criteria (effectiveness, implementability, and cost) used to screen alternatives; however, they are applied only to technologies and not to the site as a whole. The selected representative technologies are ready to be assembled into alternatives representing a range of treatment and containment combinations (subsection 3.1 of the FS). Once the alternatives are assembled, they are screened according to the criteria of effectiveness, implementability, and cost (subsection 3.2 of the FS). At this point, the remaining alternatives are then analyzed in detail (Section 4 of the FS) using the nine criteria as specified in the NCP. This process is illustrated in Figure 1.4.

Thus, each alternative is evaluated in detail using nine CERCLA evaluation criteria, which are categorized into three criteria groups:

Threshold Criteria:

> "Overall protection of human health and the environment" addresses whether a remedy provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
>
> "Compliance with applicable or relevant and appropriate requirements" (ARARs) addresses whether a remedy will meet all of the ARARs or other Federal and State environmental laws and/or justifies a waiver on the basis of technical impracticability.

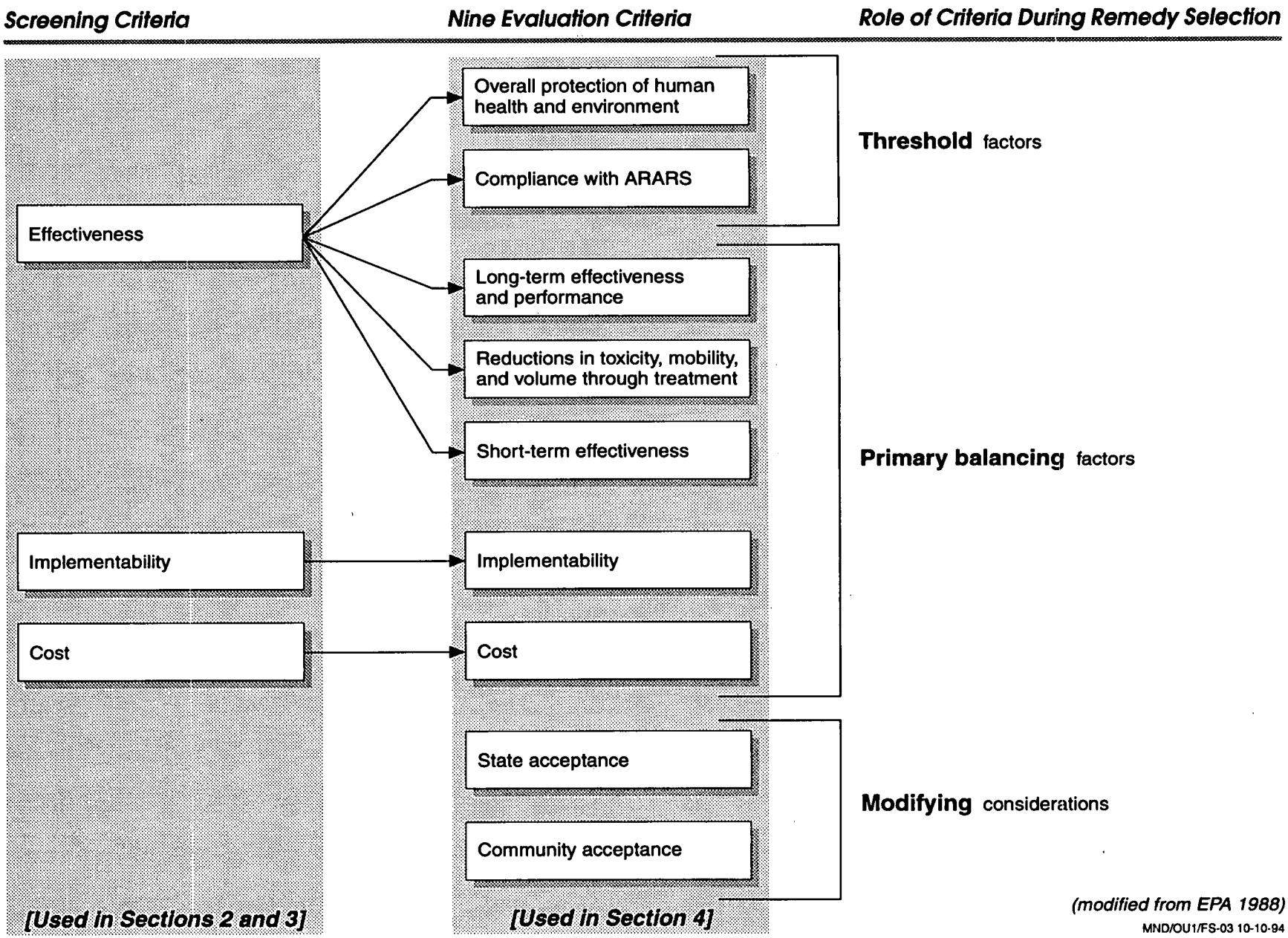


Figure 1.4. Relationship of screening criteria to the nine evaluation criteria.

Primary Balancing Criteria:

"Long-term effectiveness and performance" refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

"Reduction of toxicity, mobility, or volume through treatment" is the anticipated performance of the treatment technologies a remedy may employ.

"Short-term effectiveness" addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

"Implementability" is the technical and administrative feasibility of remedy, including the availability of materials and services needed to implement a particular option.

"Cost" includes estimated capital and operations and maintenance costs, expressed as net present worth costs.

Modifying Criteria:

"State/support agency acceptance" reflects aspects of the preferred alternative and other alternatives that the support agency favors or objects to, and any specific comments regarding State ARARs or the proposed use of waivers. The Proposed Plan does not speculate. The assessment of State concerns may not be complete until after the public comment period on the RI/FS and Proposed Plan is held.

"Community acceptance" summarizes the public's general response to the alternatives described in the Proposed Plan and in the RI/FS, based on public comments received. Like State acceptance, evaluations under this criterion usually will not be completed until after the public comment period is held.

The modifying criteria are not used to analyze the alternatives in this document. State acceptance of any of the alternatives will be determined by draft-document review by the Ohio EPA. After the FS report is finalized and the proposed plan is released, a public comment period will follow. The nature of the public comments will determine the public acceptance of any alternative.

2. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents the remedial action objectives, general response actions, and volumes and areas of media to be remediated. The section also presents the potentially applicable technology types and process options and the screening results. After presenting these results, the selected representative technologies are assembled into alternatives. These alternatives are then evaluated and screened with respect to technical implementability in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988) and the Mound Plant FFA (EPA 1990a).

2.1. DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

This subsection presents the development of remedial action objectives for soils and for groundwater within Operable Unit 1, Area B. For each medium, the objectives will specify

- contaminants of concern (COCs),
- actual and potential exposure pathways,
- acceptable contaminant levels based on ARARs, and
- risk-based preliminary remediation goals (PRGs).

The objectives are based on public health and environmental criteria; EPA and OEPA (Ohio Environmental Protection Agency) guidance and practices; the National Contingency Plan (NCP); and the requirements of applicable federal and state environmental standards, guidance, and advisories as defined under state law and the Superfund Amendments and Reauthorization Act (SARA), Section 121. The ARARs that have been compiled and submitted to regulatory authorities for review are presented in Appendix A and are the basis of this evaluation.

2.1.1. Contaminants of Concern, Exposure Routes, and Receptors for Soils and Groundwater

The COCs for soil and groundwater were determined by the baseline risk assessment conducted for the Operable Unit 1 RI (DOE 1994a). In this assessment, both residential and industrial scenarios were used to calculate risks. The residential scenario results will be used for the groundwater pathway evaluation in order to protect the maximum potential use of this resource. However, based on the planned future use of the site, the industrial scenario will be used for soil.

An evaluation of potential ecological impacts of Area B was not conducted as part of the RI. The ecological assessment for the site is currently being completed. The issue will be addressed in the final

determination for the Site as a whole if results indicate that a significant potential for impacts to ecological receptors exists.

Soils

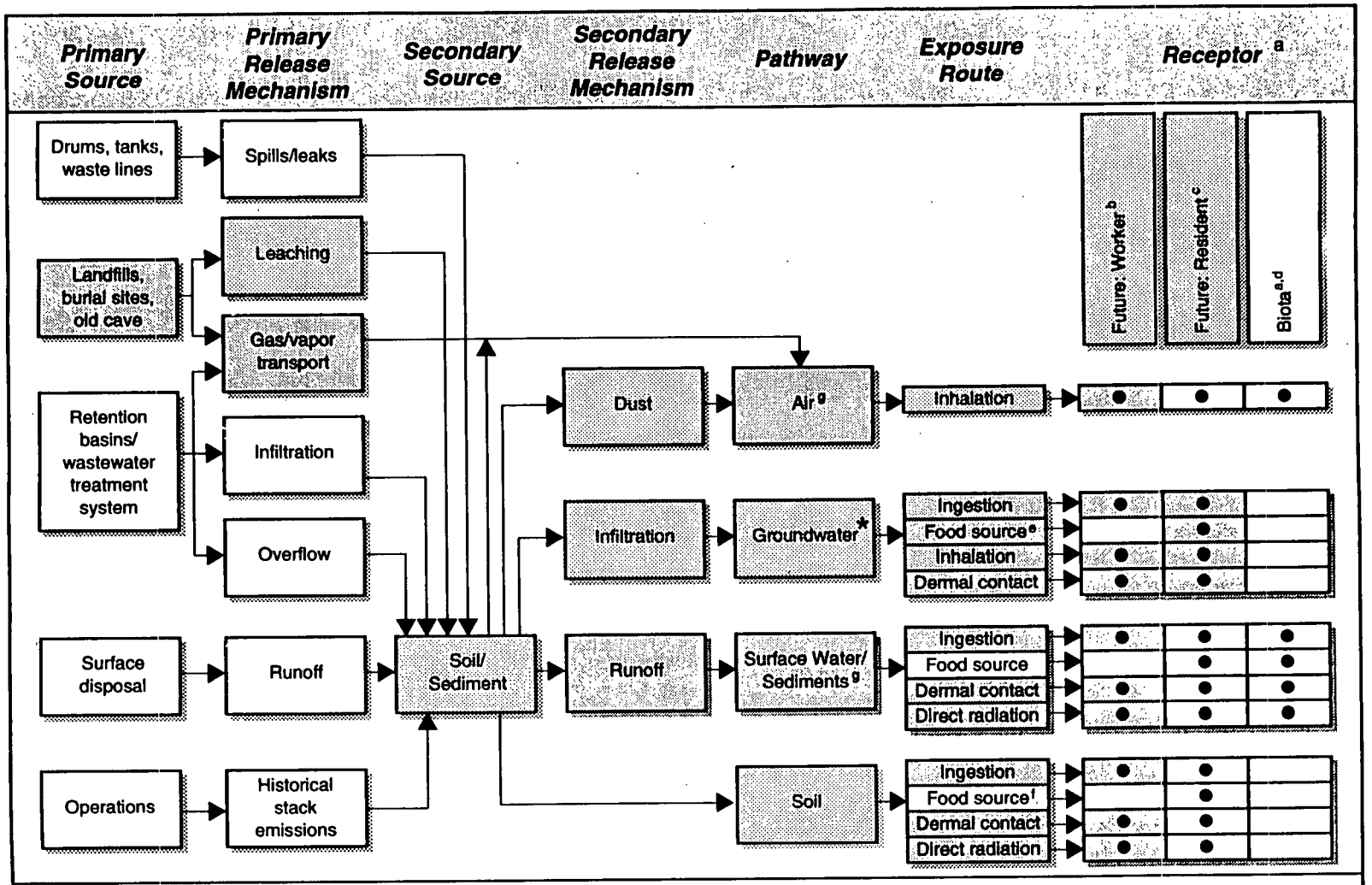
A conceptual pathway model of sources, exposure routes, and receptors at Area B, Operable Unit 1, is shown in Figure 2.1. The former waste disposal areas within Area B (the historic landfill and associated features) are the primary source areas from which contaminants have entered or may continue to enter the environment. These areas are concentrated beneath and immediately adjacent to the current site sanitary landfill. As described in subsection 1.2, these waste disposal areas resulted from over 30 years of various disposal activities, as well as the eventual placement of wastes into the site sanitary landfill. At present, the area south of the overflow pond can be considered as heterogeneous and variably contaminated. Contaminants and their concentrations are described in the RI report (RIR) (DOE 1994a).

The primary release mechanisms from these sources include infiltration, leaching, and runoff. These releases have led to contamination of soil and other unconsolidated deposits with the COCs described below. Contaminated soils are a potential direct route for exposure to humans and biota through incidental ingestion, dermal contact, and external exposure to radiation. Secondary routes of exposure may occur due to uptake by flora and fauna, resuspension of dust, vapor transfer into the air, and groundwater contamination.

The baseline risk assessment evaluated potential exposure to soils by industrial workers. Two types of industrial workers were evaluated: an indoor worker and an outdoor worker. The outdoor worker experienced higher exposures to soil contaminants and will, therefore, be used to determine soil COCs. This contamination scenario includes exposure from the following soil pathways:

- inhalation of outdoor particulates and vapors originating from soil,
- incidental ingestion of soil,
- external exposure to radiation emitted from radionuclides in soil, and
- dermal contact with chemicals in soil.

The results of the risk assessment of the future outdoor worker are shown in Table II.1. Two of the contaminants of potential concern (COPCs) that were evaluated in the baseline risk assessment were found to have RME lifetime excess cancer-risks above 1×10^{-6}. 2,3,7,8-TCDD and benzo(a)pyrene each had an estimated excess cancer-risk of 2×10^{-6}. For noncarcinogens, the hazard index (the sum of the individual hazard quotients) was less than 1 for soil, indicating that noncarcinogenic health effects are not of concern.



LEGEND

a ECOLOGICAL RISK assessment to be conducted in OU9.

b FUTURE WORKER – Works outside or within a building on the site as a laborer. Receptor is exposed to contaminants in environmental media; not an evaluation of occupational exposure.

c FUTURE RESIDENT – Uses groundwater onsite.

d TERRESTRIAL BIOTA – Analysis of terrestrial biota will include quantitative analysis to the extent possible but will not be possible for all exposure routes such as dermal contact.

e FOOD INGESTION from the groundwater pathway will be based on consumption of vegetables grown in gardens irrigated with contaminated groundwater.

f FOOD INGESTION from the soil pathway will include ingestion of plants that have taken up contaminants from soil.

g INVESTIGATION to be conducted in OU9 (DOE 1992b).

● Possible intersection of pathway and receptor.

* Because there are two groundwater receptors, future worker and future resident, being used, the higher of the two risk calculations will be used in the assessment.

NOTE: Shaded areas indicate aspects relevant to Area B Feasibility Study

MND/OU1/FS-ConMod-1/9-29-94

Figure 2.1. Conceptual pathway model for Area B, Operable Unit 1 Feasibility Study.

Table II.1. Risks for Reasonable Maximum Exposure to Soil for Outdoor Industrial Worker

Soil Contaminants[a]	Carcinogenic Risk	Noncarcinogenic Hazard Quotient
2,3,7,8-TCDD (Dioxins)	2×10^{-6}	NA
Aroclor-1248 (PCB)	8×10^{-7}	NA
Benzo(a)anthracene	2×10^{-7}	NA
Benzo(a)pyrene	2×10^{-6}	NA
Benzo(b)fluoranthene	2×10^{-7}	NA
Indeno(1,2,3-cd)pyrene	1×10^{-7}	NA
Plutonium-238	8×10^{-7}	NA
Total Risk	6×10^{-6}	NA

Ref: DOE 1994a
[a]Soil contaminant is any contaminant with an excess cancer-risk greater than 1×10^{-7} or a hazard quotient greater than 0.1.

PCB - polychlorinated biphenyl

Groundwater

Infiltration of water into the subsurface in Area B has caused leaching and movement of some contaminants into the groundwater system. Future exposure to contaminated groundwater originating from Area B could result from use of the plant production wells, installation of new wells, and/or migration offsite (outside Area B) of the contaminant plume. Production well 1 (0071) has been shut down because of increasing levels of VOCs in the discharge water, and production well 3 (0076) is now the primary source of process and potable water for the plant. Production well 2 (0271) is pumped as required to provide a supplemental source of plant water. Eventually, groundwater contaminants could move offsite.

In the baseline risk assessment, risks associated with future potential residential use of groundwater were evaluated. In this evaluation, data from the most contaminated wells within Area B were combined. The groundwater pathways in this scenario including the following:

- ingestion of groundwater,
- incidental ingestion and dermal contact with groundwater used in a swimming pool,
- ingestion of groundwater-irrigated produce,
- ingestion of meat from livestock watered with contaminated groundwater, and
- dermal contact and inhalation of VOCs while showering with groundwater.

The results of the risk assessment on the future farmer resident are shown in Table II.2. Eleven of the COCs that were evaluated in the baseline risk assessment were found to have lifetime excess cancer-risks above 1×10^{-6}. For the RME, the following seven organics and four radionuclides had an estimated excess cancer-risk greater than 1×10^{-6}:

- Alpha-chlordane
- 1,2 dichloroethane
- tetrachloroethene (PCE)
- tetrachloromethane (carbon tetrachloride)
- trichloroethene (TCE)
- trichloromethane (chloroform)
- vinyl chloride (chloroethene)
- actinium-227
- plutonium-238
- plutonium-239/240
- tritium.

For noncarcinogens, the hazard index for the groundwater pathway was 36 (Table II.2). The hazard quotients that exceed 0.1 are all chlorinated organics (i.e., 1,2 dichloroethane, 1,2-*cis*-dichloroethene [DCE], chlordane, PCE, tetrachloromethane, TCE, and trichloromethane). For these compounds, it is

Table II.2. Reasonable Maximum Exposure Risks from Residential Groundwater Use

Contaminant of Concern[a]	Carcinogenic Risk	Noncarcinogenic Hazard Quotient
1,2 dichloroethane	3×10^{-6}	0.8
1,2-*cis*-dichloroethene	NA	1.0
Chloroethene (vinyl chloride)	7×10^{-5}	NA
Tetrachloroethene (PCE)	2×10^{-4}	2.2
Tetrachloromethane (carbon tetrachloride)	2×10^{-5}	31
Trichloroethene (TCE)	4×10^{-5}	1.0
Trichloromethane (chloroform)	1×10^{-4}	0.2
Alpha-chlordane	9×10^{-6}	0.3
Actinium-227	2×10^{-5}	NA
Plutonium-238	4×10^{-6}	NA
Plutonium-239/240	1×10^{-5}	NA
Tritium	9×10^{-6}	NA
Total Risk	5×10^{-4}	36

Ref: DOE 1994a

[a]Groundwater contaminant of concern is any contaminant with an excess cancer-risk greater than 1×10^{-6} or a hazard quotient greater than 0.1.

NA - not applicable

reasonable to assume additive effects. Therefore, COPCs having a hazard quotient greater than 0.1 are retained as COCs. This retention includes six of the seven organic carcinogenic COCs plus 1,2-*cis*-DCE.

2.1.2. Allowable Exposures and Preliminary Remediation Goals

Soils

Only two of the soil contaminants had concentrations potentially associated with excess cancer-risks greater than 1×10^{-6}. The combined carcinogenic risk of these two compounds is 4×10^{-6}. Because the NCP specifies a target cancer-risk range of 1×10^{-4} to 1×10^{-6}, and because this risk is already near the lower end of this range, the soil pathway may not need further consideration. However, three additional factors must be considered when setting remedial action goals for soil:

- Upon completion of the ecological risk assessment, soil concentrations must be evaluated for potential environmental impact.
- Soil contamination requires evaluation regarding its contribution to groundwater contamination.
- The current soil data may not fully characterize the range of contamination.

If hot spots are detected during implementation of a remedial action or other activity, the contamination must be evaluated on a case-by-case basis. The PRGs determined for these hot spots would be risk-based; however, chemical-specific PRGs are not proposed here because the size and location of the hot spots would significantly affect potentially applicable soil exposure pathways.

Groundwater

The ARARs for groundwater include the maximum contaminant levels (MCLs) from the federal Safe Drinking Water Act and the Ohio Drinking Water Rule standards for the state of Ohio. These MCLs are shown in Table II.3 for the COCs in groundwater. Risk-based PRGs are also presented in Table II.3. For carcinogens, these goals are based on a target lifetime excess cancer-risk of 1×10^{-6}.

Based on the ARARs, risk-based PRGs, and analytical quantitation limits, PRGs are proposed as shown on Table II.3. It is assumed that all carcinogens (radionuclides and carcinogenic, chlorinated organics) are additive. For the purposes of these proposed PRGs, it is assumed that the combined carcinogenic risk cannot exceed 1×10^{-4}. The carcinogenic organics include all the listed organics other than

Table II.3. Preliminary Remediation Goals

Constituent	Risk-based Preliminary Remediation Goal[a] (μg/L)	SDWA MCL[b] (μg/L)	Ohio Drinking Water Rule[b] (μg/L)	Maximum Concentration[c] (μg/L)	Estimated Quantitation Limit (μg/L)	Proposed Preliminary Remediation Goal (μg/L)	Lifetime Risk at Proposed PRG
1,2 dichloroethane	0.1	NL	NL	ND	0.3	0.3	3×10^{-6}
1,2-*cis*-dichloroethene	60	70	NL	12	1.0	60	HQ = 1
Tetrachloroethene	1	5	NL	2.5	0.3	5	5×10^{-6}
Tetrachloromethane	0.2	5	5	ND	1.2	1.2	6×10^{-6}
Trichloroethene	2	5	5	ND	1.2	2	1×10^{-6}
Trichloromethane	0.2	100	100	14	0.5	2	1×10^{-5}
Chlordane(alpha)	0.06	2	NL	ND	0.05	0.06	1×10^{-6}
Actinium-227[d]	0.1	NL[e]	NL	1.6	0.2	1	1×10^{-5}
Plutonium-238[d]	0.2	15[f]	NL	0.0536	0.2	0.2	1×10^{-6}
Plutonium-239/240[d]	0.2	15[f]	NL	0.317	0.2	0.6	3×10^{-6}
Tritium[d]	900	20,000	20,000	4,220	500	3,000	3×10^{-6}
Vinyl chloride	0.02	2	2	3.6	1.0	1	5×10^{-5}

[a]Risk-based preliminary remediation goals, concentration from residential water use scenario. When a contaminant had both carcinogenic and noncarcinogenic risks, the lower was chosen. Risk-based PRGs were calculated as shown below.
[b]See Appendix A
[c]Values listed are the maximum detected values outside of the remediation area (wells 71, 154, 155, 377, and 378)
[d]pCi/L
[e]The proposed MCL for beta and photon emitters is 4 mrem ede/yr with a screening level of 50 pCi/L.
[f]MCL listed is a proposed value for adjusted gross alpha.

NL - not listed
ND - not detected

$$\text{Chemical Carcinogen Risk-based PRG } (\mu g/L) = \frac{TR \times BW \times AT \times 1000\ \mu g/mg}{EF \times ED \times ([VF \times IRA \times SF_i] + [IRW \times SF_o])}$$

$$\text{Noncarcinogen Risk-based PRG } (\mu/L) = \frac{TR \times BW \times AT \times 1000\ \mu g/mg}{EF \times ED \times \left[\frac{VF \times IRA}{RfD_i} + \frac{IRW}{RfD_o}\right]}$$

$$\text{Radionuclide Carcinogen Risk-based PRG } (pCi/L) = \frac{TR}{EF \times ED \times ([VF \times IRA \times SF_i] + [IRW \times SF_o])}$$

Where:

TR = Target risk (1×10^{-6} for carcinogens, hazard quotient of 1 for noncarcinogens)
BW = Body weight (age-adjusted for carcinogens-59 kg, for noncarcinogens - 70 kg)
AT = averaging time (25,550 days)
EF = exposure frequency (350 days/year)
ED = exposure duration (30 years)
VF = volatilization factor (where applicable = 0.5)
IRA = inhalation rate (age-adjusted for carcinogens - 19 m^3/day, for noncarcinogens - 20 m^3/day)
IRW = ingestion rate of water (age-adjusted for carcinogens - 1.8 L/day, for noncarcinogens - 2 L/day)
SF_i = inhalation slope factor (chemicals - kg-day/mg, radionuclides 1/pCi)
SF_o = oral slope factor (chemicals - kg-day/mg, radionuclides 1/pCi)
RfD_i = inhalation reference dose (kg-day/mg)
RfD_o = oral reference dose (kg-day/mg)

1,2-*cis*-dichloroethene. The proposed PRG for 1,2-*cis*-dichloroethene is set at its risk-based PRG assuming a hazard quotient of 1. Trichloroethene, chlordane, and plutonium-238 have proposed PRGs at their respective risk-based PRGs, equating to carcinogenic risks of 1×10^{-6} each. The proposed PRG for vinyl chloride is set at its quantitation limit, which corresponds to a cancer-risk of 5×10^{-5}. 1,2 Dichloroethane and tetrachloromethane are also set at their quantitation limits. To keep the combined carcinogenic risk less than 1×10^{-4}, the remaining risk was divided among trichloromethane, 1×10^{-5} at the proposed PRG, tetrachloroethene, 5×10^{-6} at the proposed PRG, actinium-227, 1×10^{-5} at the proposed PRG, and tritium and plutonium-239/240, each at 3×10^{-6} at the proposed PRG. The aggregate carcinogenic risk at the proposed PRGs is 9.4×10^{-5}. This value allows some room for additional risk from unanticipated pathways or contaminants such that when risk from all pathways are evaluated and all contaminants are included, the total exposure risk for the Operable Unit 1 area will not exceed 1×10^{-4}.

None of the proposed PRG values exceed MCLs, and in order to keep aggregate risks less than 1×10^{-4}, the proposed PRG for many contaminants are substantially below their MCLs. These proposed PRGs are one of many ways risk could be apportioned to the various chemicals and are intended to provide a basis for evaluating various remedial alternatives.

2.1.3. Remedial Action Objectives

Remedial action objectives are general descriptions of how the remedial actions will protect human health and the environment and achieve the more specific remediation goals (EPA, 1988).

Soils

To protect human health, the soil remedial action objective will include prevention or reduction of infiltration and migration of contaminant, which would result in groundwater contamination in excess of remediation goals. Additionally, soil contaminants should not lead to an aggregate excess cancer-risk greater than 1×10^{-5} or a hazard index greater than one for occupational exposures.

Groundwater

To protect human health, the groundwater remedial action objective will include prevention of ingestion of water with contaminant concentrations in excess of remediation goals. To protect environmental health, the objective will include reduction or control of contaminant concentrations to meet remediation goals in the aquifer adjacent to Area B.

2.2. GENERAL RESPONSE ACTIONS AND VOLUMES/AREAS OF CONTAMINATION

2.2.1. Description of General Response Actions

General response actions are actions that will satisfy the remedial action objectives described previously. The general response actions for Mound Plant Operable Unit 1 are

- No action—provides a baseline for comparison with other alternatives and is required by the NCP for the FS process.
- Institutional controls—prevent human exposure to the identified COCs but do not address reducing the toxicity, mobility, or volume of contamination.
- Containment—limits or controls the migration of contaminants beyond the present area of contamination into adjacent areas but does not contribute to reducing the toxicity or volume of contamination.
- Collection—removes contaminated media to facilitate treatment or disposal actions.
- Treatment—uses processes, implemented *in situ*, onsite, or offsite, to reduce the toxicity, mobility, or volume of contaminants in the affected media.
- Disposal (in association with the collection or treatment actions)—determines the ultimate location of treated or untreated media in an environmentally sound, publicly acceptable, and cost-effective manner.

2.2.2. Areas and Volumes of Contaminated Media

Areas and volumes of contaminated and potentially contaminated media in Area B were estimated based on geologic cross sections and topography (Appendix B). Two general types of contaminated media were identified at Operable Unit 1: soils (and other unconsolidated unsaturated materials) and groundwater.

Soils

The soils and other unconsolidated materials above the water table are divided into three different material types: till, outwash, and fill. The volume of unconsolidated deposits and soils above the water table, excluding the landfill materials, is estimated to be 2,530,000 cubic feet (cu ft). Further, the site sanitary landfill is composed of three general material types: the cover, the contents of the landfill, and the landfill liner. The areas and volumes of each of these material types from the ground surface to the average water table are estimated separately (Appendix B).

Groundwater

The volume of groundwater beneath Area B was estimated as the volume between the average water table surface and the top of the bedrock, using the porosity reported in the RI report (Appendix B). Because of the diffuse nature of the contamination, the total volume was estimated instead of attempting to delineate plumes for specific contaminants. The estimated total volume of groundwater beneath Area B is approximately 207,000 cu ft (1,551,000 gallons). Because of contaminant interactions with the aquifer matrix material (adsorption and desorption), it is likely that the extraction of more than one pore volume would be required to satisfy the remedial action objectives.

2.3. IDENTIFICATION, INITIAL SCREENING, AND EVALUATION OF REMEDIAL TECHNOLOGY TYPES AND PROCESS OPTIONS

2.3.1. Identification And Screening of Technologies

The technology types associated with each general response action for soil and groundwater are summarized in Tables II.4 and II.5, respectively. These technology types and process options represent the range of remedial technologies potentially applicable to contaminated soil and groundwater. General descriptions of the process options are presented in Appendix C.

The preliminary remedial technologies were screened based on technical implementability using site and waste characteristics (Tables II.4 and II.5). The screening process eliminated those technologies which had severe limitations for the site- and waste-specific conditions of Operable Unit 1. Technologies that proved to be extremely difficult to implement, required unreasonable time periods, or relied on insufficiently developed technology were eliminated. Technologies retained through the screening process are considered to contribute to protection of human health and the environment and to be suitable for further analysis.

The process options for the soil and groundwater mediums retained for further analysis are shown in Table II.6.

Some consideration had been given to large-scale excavation and removal of the site sanitary landfill and the underlying materials associated with the historic landfill. However, the large quantities of materials involved (up to 150,000 yd^3), coupled with the expense of excavation, treatment, and redisposal (perhaps $70 to $120 million), militate against such an option. The anticipated costs are an order of magnitude greater than other options that have been found to be protective of human health and the environment. Further, the environmental impact of such a large-scale operation, itself,

Table II.4. Initial Screening of Preliminary Remedial Technologies for Soil

General Response Action	Remedial Technology Type	Technology Process Option	Technical Implementability	Reference	Screening Results
No action	No additional action	No action	Consideration required by National Contingency Plan.	(a)	Retained
Institutional	Monitoring	Long-term monitoring of contamination	Involves monitoring groundwater for contaminants leached from soils. Potentially applicable with most alternatives. As stand-alone alternative, applicable to low mobility contaminants.	(a)	Retained
	Access restriction	Access Restriction	Potentially applicable with most alternatives. Not often used as a stand-alone alternative.	(a)	Retained
Containment	Capping	Flexible membrane liner (FML)	Prevents precipitation from infiltrating the area of contamination thereby isolating the source of groundwater contamination. Potential to deteriorate with exposure to weather. Long-term maintenance required.	(b)	Retained
		Low permeability soil liner	Prevents precipitation from infiltrating the area of contamination thereby isolating the source of groundwater contamination. Long term maintenance required.	(b)	Retained
		Composite liner	Consists of a combination of FML and low-permeability soils. Long term maintenance required.	(b)	Retained
		surface sealing: - soil admixtures - asphalt - concrete	Rigid cap of various materials including asphalt and concrete. Susceptible to deterioration from differential settling and freeze/thaw cycles. Long term maintenance required.	(b)	Screened
	Bottom sealing	Grout injection	Technology experimental. Because the site sanitary landfill and overflow pond cover most of Area B, grout cannot be injected under most contaminated soils.	(b)	Screened
		Block displacement	Technology experimental. Involves displacement of a block of contaminated soil by grout injection underneath. The presence of the landfill and pond over most of the contaminated soil area precludes this technology.	(b)	Screened
	Surface controls	- regrading - revegetation - diversion - collection ditches - sedimentation basins	Use as part of an overall alternative plan is potentially applicable to prevent erosion of shallow soils. Long term maintenance required. Not applicable to landfill or pond but to drainages along the western and southern edge of the landfill.	(b)	Retained
Collection	Excavation	Soil excavation	Site sanitary landfill and overflow pond overlie most of Area B making large-scale excavation prohibitive.	(b)	Screened
Treatment	*In situ*: Bioremediation	Bioremediation	Involves the use of naturally occurring microorganisms in the soil to degrade hydrocarbon contaminants. Certain halogenated hydrocarbons may require anaerobic degradation. Reducing conditions would be impractical to maintain in unsaturated zone. Injection of nutrients under site sanitary landfill would also be technically difficult.	(c)	Screened

Table II.4. (page 2 of 4)

General Response Action	Remedial Technology Type	Technology Process Option	Technical Implementability	Reference	Screening Results
	In situ: Physical/Chemical	Electrical Separation	Involves inducing an electrical current in the soil which causes migration and concentration of contaminants for their removal. Technology is in experimental stage for depths below 10 feet. The placing of numerous electrodes under site sanitary landfill is technically impractical.	(c)	Screened
		Detoxification	Methods include neutralization, hydrolysis, and oxidation/reduction by injection of chemical compounds into the unsaturated zone. By-products could form and leach into groundwater. Injection into contaminated soils beneath landfill and pond is technically impractical.	(b)	Screened
		Solidification/ stabilization	Involves injecting chemical compounds into contaminated soil which render contaminants insoluble or bind contaminants chemically to soil matrix. Injection into soils beneath landfill and pond is technically impractical.	(d)	Screened
		Soil flushing/extraction	Involves injection of an aqueous fluid into contaminated soils causing mobilization of sorbed contaminants. The solution is then extracted for treatment, then recirculated. Contaminated fluids could leach into groundwater and bypass collection wells creating additional source term. Injection beneath landfill and pond is precluded.	(d)	Screened
		Soil vapor extraction	Involves vacuum extraction of VOCs from unsaturated zone. Technology is readily available. Effective for all VOCs. May be difficult to implement for contaminated soils under landfill.	(d)	Retained
		Pneumatic fracturing	Involves fracturing of low permeability zones to increase rate of vapor extraction. May be applicable to till layer under most of Area B. May allow for vapor extraction underneath landfill.	(d)	Retained
	In situ: Thermal	Radio frequency heating	Involves heating contaminated soils with radio frequency generators to volatilize and pyrolytize hydrocarbon contaminants. Technology is in bench-scale stage. Would be technically impractical for the entire area of soils underlying landfill.	(e)	Screened
		Vitrification	Involves the conversion of contaminated soils into molten glass. This process uses large amounts of energy. May need to treat off-gases. Cannot be done beneath landfill or pond. Designed primarily for metals and radionuclides.	(e)	Screened
	Onsite: Bioremediation	Bioremediation	Involves controlled use of microorganisms to decompose hydrocarbon contaminants. Most effective as a treatment of petroleum hydrocarbons. Removal of soils beneath landfill and pond prohibitive.	(b)	Screened

Table II.4. (page 3 of 4)

General Response Action	Remedial Technology Type	Technology Process Option	Technical Implementability	Reference	Screening Results
	Onsite: Physical/Chemical All *ex situ* methods require excavation of the contaminated soils. The landfill and overflow pond cover most of Area B. For contaminated soils underlying the landfill and pond, excavation is technically impractical. This is the primary screening criteria for the *ex situ* onsite methods.	Soil washing	The soil washing process extracts contaminants from soil using a liquid medium such as water, a surfactant, or solvent. A liquid waste stream is generated which must be treated or disposed. Inefficient for silt and clay particle sizes which occur in shallow till onsite. Removal of soils beneath landfill and pond prohibitive.	(c)	Screened
		Dechlorination	Cost-effective methods for decontamination of halogenated compounds in dilute quantities in soil matrices are not available. Primarily applicable to complex aromatics such as pesticides and PCBs. Not effective for metals or radionuclides. Removal of soils beneath landfill and pond prohibitive.	(c)	Screened
		Solidification/ stabilization	Involves the application of bonding agents to soils to immobilize contaminants. The waste is then disposed offsite. Technology in pilot-scale development. Removal of soils beneath landfill and pond prohibitive.	(c)	Screened
		UV photolysis	Involves exposure of contaminated soil to ultraviolet radiation which decomposes organic compounds. Not effective for metals or radionuclides. Removal of soils beneath landfill and pond prohibitive.	(f)	Screened
	Onsite: Thermal	Incineration	Employs thermal decomposition of organic compounds through oxidation at high temperatures. Effective for treatment of VOCs. May require permit for off-gases. Commonly used process. Removal of soils beneath landfill and pond prohibitive.	(b)	Screened
		Low-temperature thermal desorption	Uses direct or indirect heat exchange to vaporize organic contaminants from soils. The vapors are collected and/or condensed for further treatment. Efficient treatment for VOCs. Not effective for metals or radionuclides. Removal of soils beneath landfill and pond prohibitive.	(c)	Screened
		Vitrification	Involves combining contaminated soils with molten glass and cooled to a stable solid. Energy intensive, so has been restricted to highly toxic wastes. May have to control off-gas. Removal of soils beneath landfill and pond prohibitive.	(c)	Screened
	Offsite	Offsite facility	Involves excavation, containerization, and shipment of contaminated soils to remote facility for treatment. Mainly applied to localized zones of high contamination. Removal of soils beneath landfill and pond prohibitive.	(c)	Screened

Table II.4. (page 4 of 4)

General Response Action	Remedial Technology Type	Technology Process Option	Technical Implementability	Reference	Screening Results
Disposal	Treated Soils				
	Onsite disposal: - treated soil - treatment residuals	New onsite landfill	Landfill cannot be placed above sole-source aquifer. Some waste residuals may not be landfilled based on Land Ban restrictions. Removal of soils beneath landfill and pond prohibitive. No new landfills are planned for the Mound Plant.		Screened
	Offsite disposal: - treated soil - treatment residuals	Offsite landfill	Some contaminated soils or waste residuals may not be allowable based on Land Ban restrictions. Removal of soils beneath landfill and pond prohibitive. Treatment residuals or other solid waste may be suitable for disposal at solid waste facility.		Retained
	Untreated Soils				
	Onsite disposal	New Onsite Landfill	Landfill cannot be placed above sole-source aquifer. Disposal of untreated hazardous waste is not allowed by Land Ban regulations. Removal of soils beneath landfill and pond prohibitive. No new landfills are planned for Mound Plant.		Screened
	Offsite disposal	Offsite landfill	Some contaminated soils may not be allowable based on Land Ban restrictions. Removal of soils beneath landfill and pond prohibitive.		Screened

(a) 40 CFR Part 300, National Oil and Hazardous Substances Pollution Contingency Plan
(b) EPA 1985
(c) EPA 1994
(d) EPA 1992
(e) Rich and Cherry 1987
(f) Freeman 1989

Table II.5. Initial Screening of Preliminary Remedial Technologies for Groundwater

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
No action	No additional action	No action	Consideration required by National Contingency Plan.	(a)	Retained
Institutional controls	Monitoring	Long-term groundwater monitoring	Potentially applicable with most alternatives. As a stand-alone alternative, applicable to low mobility contaminants or contaminants susceptible to natural degradation.	(a)	Retained
	Access Restriction	Access Restriction	Potentially applicable with most alternatives. Not often used as a stand-alone alternative.	(a)	Retained
Containment	Vertical barriers	Slurry wall	Soil/bentonite slurry placed in trench around source areas prevents outward flow of contaminated groundwater. Low maintenance compared to groundwater extraction. Requires long-term maintenance and monitoring.	(b)	Retained
		Slurry columns	Bentonite mixed into soil with specialized auger equipment. Overlapping borings are drilled in a row to create a barrier. Requires long-term maintenance and monitoring.	(c)	Retained
		Sealable sheet piling	This option is known as the Waterloo Barrier. Uses interlocking joints to form a seal with conventional sheet piling technology. Less site disruption and worker exposure during construction than slurry wall.	(d)	Retained
		Grout curtain	Grout is injected through tubes placed in closely spaced boreholes. Susceptible to shrinkage and cracking.	(b)	Screened
	Hydraulic barriers	Pumping well system	Extraction wells are used to form a groundwater divide which intercepts contaminated groundwater. This option is very versatile and can be used to contain contaminant migration. Transmissivities of the glacial outwash are sufficient for this option. Long term maintenance is required.	(b)	Retained
		Trench collection system	Subsurface trenches are used to intercept contaminated groundwater. Transmissivities of the glacial outwash are sufficient for use of this option. Trenches can eliminate or reduce the number of wells needed to contain contaminated groundwater. Long term maintenance is required.	(b)	Retained
Collection	Vertical systems	Pumping well system	Extraction wells are used to capture and extract all contaminated groundwater which could migrate offsite. Transmissivities of the glacial outwash are sufficient for use of this option. Long term maintenance is required.	(b)	Retained
		Well point system	Effective only for shallow depths and lift of less than 22 ft. Depth to water is approximately 29 feet.	(b)	Screened

Table II.5. (page 2 of 8)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
	Horizontal systems	Trench collection system	Subsurface trenches are used to intercept and extract contaminated groundwater. Transmissivities of the glacial outwash are sufficient for use of this option. This option can eliminate or reduce the number of wells needed for groundwater extraction. Long term maintenance is required.	(b)	Retained
		Horizontal well system	Uses proven drilling techniques to drill horizontal wells. This option does not disturb the site as much as trenching. May be difficult in glacial outwash.	(e)	Retained
Treatment	*In situ*: Physical/Chemical	Geochemical fixation	Involves injection of chemical which cause fixation of contaminants onto aquifer material. No change in chemical toxicity. Geochemical conditions could return to original state at some time in future causing remobilization of contaminants. Effectiveness dependant upon subsurface properties. Particularly applicable to metal and radionuclide wastes.	(c)	Screened
		Chemical injection	Chemical-enhanced solubilization using surfactants for retrieval of NAPLS. Contaminants found on-site have not exceeded solubility limits and therefore do not exist in concentrated NAPL form.	(c)	Screened
		Permeable treatment walls:			
		- iron-based reactor material	A metal (usually iron) is placed in the subsurface to intercept contaminated groundwater. The metal enhances abiotic degradation of halogenated organic compounds. Passive treatment. Can operate over a wide range of environmental conditions. The reactor material has a long operational life.	(d)	Retained
		- limestone	Crushed limestone is used to neutralize acidic groundwater and retain certain metals such as cadmium, iron and chromium. It is pH-dependant and metal-specific, but is good for attenuating the migration of certain heavy metals from solid waste leachates. It is more effective for retaining chromium III than chromium VI or other metals.	(b)	Screened
		- carbon	Applicable for nonpolar organic compounds only; will not remove polar organics. It is not practical for heavy metals. The likelihood of short bed-life makes the use of GAC impractical.	(b)	Screened

Table II.5. (page 3 of 8)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
		- glauconite	Glauconitic greensands potentially remove some heavy metals. Disadvantages are unknown saturation characteristics, potential for plugging over time, potential reduction of pH. Acquisition may pose a problem since glauconite is not commercially mined.	(b)	Screened
		Polymer sponge	Treats only aqueous heavy metals in both cationic and anionic states in low concentrations (ppb range). Not applicable to organics. Would require many monitoring well installations which will hold the sponges in nets.	(f)	Screened
		Hydrolysis	This technology is applicable to organics only. It is rarely used for *in situ* applications. It is difficult to apply and sensitive process controls are required. It is difficult to predict by-product formation.	(g)	Screened
		Oxidation	*In situ* application is limited in application because it is difficult to monitor and to control by-product formation. It is applicable to organics only.	(b)	Screened
		Air sparging	Process involves forcing air into aquifer causing volatilization of VOCs. The organic vapors are then extracted from the vadose zone. Glacial outwash has sufficient hydraulic conductivity for this process. Effective treatment for VOC contaminants present at site such as TCE, PCE, etc.	(h)	Retained
	In situ: Bioremediation	Enhanced bioremediation	Involves use of microorganisms to degrade organic compounds. This process option requires more time for treatment than some of the physical/chemical technologies. Although it treats organics (not inorganics), for chlorinated organics this process option may require anaerobic conditions which cannot be maintained in the field.	(g)	Screened
		TreeMediation™	Involves use of vegetation to extract shallow groundwater. This process option has not yet been tested on aquifers greater than 20 feet deep. The depth to groundwater at OU1 is greater than phreatophyte root depth.	(e)	Screened
	Onsite: Chemical/Physical	Air stripping with vapor phase treatment	This process option is for the treatment of VOCs and some semivolatile organic compounds. It is not effective for inorganics and may require pH adjustment of H_2S, phenol, ammonia, and other organic acids or bases to reduce solubility and improve transfer to the gas phase. The influent may have to be pretreated to remove Fe and Mg present in the groundwater.	(b)	Retained

Table II.5. (page 4 of 8)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
		Steam stripping	This process is more energy intensive then the simple air strip process option. It is therefore more effective at recovering wastes with high concentrations of volatile and wastes with low volatility when compared to air stripping. It is not used for treatment of inorganics. Also, the influent may have to be pretreated to remove Fe and Mg present in the groundwater.	(i)	Screened
		Cascade aerator	Originally used as an effective means of oxygenating large flows of wastewater, this process option is also used for the removal of VOCs from groundwater. It is not used for treatment of inorganics.	(k)	Retained
		Vacuum degasification	Currently vacuum degasification is a technology still in theoretical development and is an unproven technology at this point. It is for volatile organics only. This technology is similar to vapor extraction and is designed to be most effective for compounds with low Henry's Law constants.	(e)	Screened
		Thin film evaporation	This technology is primarily for treatment of sludges or viscous liquid waste streams. It is used to recover organic components and does not treat inorganics.	(i)	Screened
		Electrochemical heavy metal immobilization	The process option only treats groundwater contaminated with hexavalent chromium and other heavy metals including zinc, copper, nickel lead, and antimony which is not inclusive of all of the inorganics at OU1. The resulting solids that may form and would need disposal include chromium hydroxide, hydrous ferric oxide, and a chromium-substituted hydrous iron complex.	(f)	Screened
		High-energy electron beam	This process option destroys halogenated organic compounds. It does not treat inorganics. Requires a 1.5 megaelectron volt electron accelerator.	(f)	Retained
		UV/oxidation	This technology is primarily for organics only, particularly chlorinated hydrocarbons. Unreacted contaminants or partially oxidized residuals in the effluent may require additional treatment.	(f)	Retained
		Chemical oxidation/reduction	This process option is primarily for aldehydes, mercaptans, phenols, benzidine, unsaturated acids and certain pesticides. In some cases, undesirable by-products may be formed as a result of oxidation/reduction.	(b)	Screened

Table II.5. (page 5 of 8)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
		Granular activated carbon adsorption	This technology quickly becomes cost prohibitive when remediation goals require low vinyl chloride effluent concentrations. It is often used after other processes. It requires that influent contain less than 50 ppm suspended solids and less than 10 ppb of oil and grease.	(b)	Screened
		Resin adsorption	This process option is for the removal of organic contaminants. The resin, however, must be customized for specific contaminants of concern. Polymeric adsorbents require pretreatment of feed streams to remove suspended solids, oils and greases, and to adjust pH and temperatures. The resin must be disposed of once saturated; it cannot be regenerated.	(i)	Screened
		Membrane microfiltration (with or without precipitation)	This technology does not treat VOCs. It removes suspended solids such as heavy metals, cyanide, uranium and organic particles from liquids. It is best suited for treating wastes with solid contaminants less than 5,000 ppm. The resulting residuals ("cake") may require additional treatment prior to disposal.	(f)	Screened
		Ion exchange	This process option is for the removal of metals only. Extensive and pretreatment is required prior to ion exchange in a hazardous waste stream system. Suspended solids and nonaqueous liquids must be removed to prevent fouling and plugging of the resin bed.	(h)	Screened
		Reverse osmosis	This process can reduce concentrations of dissolved organic and inorganic solids in groundwater, but extensive pretreatment is often required, and the equipment is subject to fouling and plugging. The resulting concentrated residuals would contain hazardous constituents. Reverse osmosis units are subject to chemical attack, fouling, and plugging.	(b)	Screened
		Distillation	This technology is not suited for liquid with high viscosity at high temperatures, liquids with high solids concentrations, polyurethanes, and inorganics. It is feed-sensitive and may not be suited for highly variable waste streams; therefore, this system has limited applications in the treatment of CERCLA wastes.	(j)	Screened
		Dechlorination	Dechlorination is primarily used for PCBs and dioxins including transformer liquids. The hydrogen produced from the reaction of an alkali metal with alcohol plus the use of tetra-hydrofuran results in a fire hazard.	(g)	Screened

Table II.5. (page 6 of 8)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
		Chlorinolysis	This process option chemically converts most chlorinated organic compounds to carbon tetrachloride at high temperatures. Waste products of this process include hydrochloric acid and phosgene gas. Neutralization will produce sodium hypochlorite which must be treated prior to discharge.	(g)	Screened
	On Site: Thermal	Liquid injection incinerator	This technology is mostly used for hazardous wastestreams containing high concentration of organics. Non-oxidizable inorganics are not treated. It is for combustible liquids with little to no water content. Concentrations of organic contaminants at OU1 are too low for this high energy process.	(b)	Screened
		Plasma arc	This process option is for the destruction of organic contaminants in liquids. Thermal decomposition occurs when wastes are heated in an oxygen deficient atmosphere. The resulting offgases require treatment. The concentrations of organic contaminants at OU1 are too low for this high energy process.	(b)	Screened
		Wet-air oxidation	Wet air oxidation involves aqueous phase oxidation of dissolved or suspended organic substances at elevated temperatures and pressures. This process option is used primarily to treat concentrated waste streams containing organic and oxidizable inorganic wastes. The concentrations of organic contaminants at OU1 are too low for this high energy process.	(i)	Screened
	On Site: Biological	Conventional biological methods	Contaminant concentrations at OU1 may not be great enough to provide adequate food source. Nutrients and oxygen would have to be added to sustain microbial degradation requiring more equipment. The biomass is susceptible to elevated levels of heavy metals or halogenated organics. Also requires stable influent concentrations and environment (pH, temperature, etc.). Treatment and disposal of sludges required.	(b)	Screened
	Pretreatment:				
		Precipitation/ flocculation with sedimentation	May be used as pretreatment to other technologies. Influent metals concentration may require pretreatment for most process options; however, inorganic concentrations at OU1 do not present a problem for VOC treatment units retained for further consideration.	(h)	Screened
		Neutralization	Waste stream will not have an extreme pH requiring neutralization.	(h)	Screened

Table II.5. (page 7 of 8)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
		Granular-media filtration	Granular-media filtration is useful as a pretreatment step for adsorption processes, membrane separation processes, and ion exchange processes, which are rapidly plugged or fouled by high loading of suspended solids. However, inorganic concentrations at OU1 do not present a problem for the VOC treatment technologies retained for further consideration.	(h)	Screened
	Offsite treatment	Offsite facility	Pretreatment may be required.		Retained
Disposal	Onsite	Untreated groundwater:			
		Evaporation pond	Annual rainfall (county average is 37.5 in per year) and evaporation rates (lake evap. is about 30 in per year) do not promote net evaporation.		Screened
		Deep well injection	All of the COCs could be injected under RCRA regulations; however, a sole-source aquifer system underlies the site.		Screened
		Treated groundwater:			
		Shallow-well injection	Shallow-well injection consists of wells completed in the upper portion of the aquifer for the injection of treated groundwater. This process option will allow recharge to the upper portion of the aquifer. Injection wells are subject to biofouling and scaling.		Screened
		Infiltration gallery	An infiltration gallery consists of a trench designed to recharge the surficial aquifer. This process option will allow recharge the upper portion of the aquifer.		Retained
		Subsurface irrigation	A subsurface irrigation system for the disposal of treated groundwater is designed and operated much like a conventional wastewater leachfield. Long lengths of perforated pipes are installed beneath the ground surface in closely spaced, shallow trenches. The perforated pipes have a tendency toward fouling and plugging. It would be difficult to keep a high volume system efficiently operational.		Screened
		Surface irrigation	A surface irrigation system consists of a network of evenly spaced, high-volume spray guns spaced evenly to distribute treated groundwater over a large area of ground surface. Saturation of soils from rainfall events may create more runoff than infiltration.		Screened
	Offsite	NPDES-permitted outfall	Discharge must comply with the current facility NPDES permit. Depending on the discharge rate and contaminant concentrations, an NPDES permit modification may be required.		Retained

Table II.5. (page 8 of 8)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	References	Screening Results
		Offsite facility	Groundwater is containerized and shipped to approved facility. Pretreatment may be required.		Retained
Disposal of treatment residuals	Onsite	Landfill	Sole-source aquifer beneath site does not allow for landfill reconstruction. Land ban restriction may apply to some constituents. May contain metals and radionuclides.		Screened
	Offsite	Landfill	Land ban restriction may apply to some constituents. May contain metals and radionuclides. May require pretreatment of residuals.		Retained

COCs - contaminants of concern
TCE - trichloroethene
UV - ultraviolet
VOC - volatile organic compound

(a) 40 CFR Part 300, National Oil and Hazardous Substances Pollution Contingency Plan
(b) EPA 1985
(c) EPA 1994
(d) EPA 1993b
(e) Bowser Morner 1993
(f) EPA 1992
(g) Rich and Cherry 1987
(h) McArdle et al. 1988
(i) Breton et al. 1988
(j) Glynn et al. 1987
(k) Boyden etal., Using Inclined Cascade Aeration To Strip Chlorinated VOCs From Drinking Water Journal of American Water Works Association, 1992, Vol. 84, No. 5, pp 62-29.

Table II.6. Process Options for Soil and Groundwater Mediums Retained for Further Analysis

Options	Soil Medium	Groundwater Medium
Access restriction	X	X
Air sparging		X
Air stripping		X
Cascade aerator		X
Composite linear	X	
Flexible membrane liner	X	
High-energy electron beam		X
Horizontal well system		X
In situ permeable treatment walls		X
Infiltration gallery		X
Long-term monitoring of contamination	X	X
Low permeability soil liner	X	
No additional action	X	X
NPDES-permitted outfall		X
Offsite disposal facility		X
Offsite treatment		X
Pneumatic fracturing	X	
Pumping well system		X
Sealable sheet piling		X
Slurry columns		X
Slurry wall		X
Soil vapor extraction	X	
Surface controls	X	
Trench collection system		X
UV/oxidation		X

would be significant. The observed contamination does not warrant such a disruptive, expensive option, so excavation, treatment and redisposal will not be considered further within this analysis.

2.3.2. Evaluation and Selection of Representative Process Options

In this stage of the screening, the processes considered to be implementable were evaluated in greater detail so that one representative process option could be selected for each technology type. This process simplified the subsequent development and evaluation of alternatives. The surviving process options associated with the technology types were screened based on the criteria of effectiveness, implementability, and cost effectiveness.

The effectiveness criterion is an evaluation of

- the potential effectiveness of the process options in handling the estimated areas or volumes of contaminated media as well as meeting the remediation goals identified in the remedial action objectives,
- the potential impact to human health and the environment during the construction and implementation phase, and
- the degree to which the process options are proven and reliable with respect to the hazardous substances and site conditions.

The implementability criterion is an evaluation of both the technical and administrative feasibility of implementing each of the technology options. Because the technical implementability had been previously considered during the preliminary screening of technology types, this more detailed evaluation placed greater emphasis on the institutional aspects of implementability such as the ability to obtain required permits for offsite actions, availability of treatment, storage and disposal services (including capacity), and the availability of equipment and skilled workers necessary to implement the process option.

The cost criterion is an evaluation of the costs of the various process options within a given technology type; however, costs play a limited role at this point in the screening process. Relative capital and O&M costs were used as opposed to detailed cost estimates. The cost evaluation was made based on best engineering judgment, and each process option was evaluated as to whether costs were high, medium, or low relative to other process options within the same technology type.

The screening of the process options associated with each technology type for soil and groundwater are summarized in Tables II.7 and II.8, respectively. Table II.9 presents all process options selected to this point.

2.3.2.1. Screening of Technology Process Options for Soil Medium

In the following section, the alternatives for treatment of the soil medium are examined based on the previously discussed criteria.

No Action

Under the no-action alternative, no further remedial action would take place at the site. Current contamination would be left in place, and no changes in contaminant levels would be expected except those resulting from natural processes.

Effectiveness

The no-action option will not result in the attainment of the PRGs or significant reduction of health risks within the foreseeable future. Some degradation of organics may occur over time by natural processes such as biodegradation. Metals concentrations in the unsaturated soil medium are not expected to diminish over time. The no-action option may not achieve remedial objectives; however, it is retained as a basis for comparison with other alternatives and is required by the NCP.

Implementability

Implementability is not an issue with the no-action alternative as it involves no action.

Cost

The no-action alternative involves no cost.

Institutional Action: Long-term Monitoring and Access Restriction

Institutional action includes restricted access to and long-term monitoring of Area B. A long-term groundwater monitoring program would be used to determine if additional contaminants were leaching from the soil medium and contributing to the existing groundwater contamination. Restricted access, such as fencing, creates a physical barrier to prevent human access to Area B.

Table II.7. Screening and Selection of Representative Process Options for Soil Medium

General Response Action	Remedial Technology Type	Technology Process Option	Effectiveness	Implementability	Cost	Screening Results
No action	No additional action	No action	Will not result in the attainment of the preliminary remediation goals in the foreseeable future.	Consideration required by National Contingency Plan. Could be readily implemented.	N/A	Retained
Institutional controls	Monitoring	Long-term monitoring of contamination	Will not result in the attainment of the preliminary remediation goals in the foreseeable future.	Can be readily implemented.	Low	Retained
	Access restriction	Access Restriction	No near term reduction in toxicity, mobility, or volume of contaminants. Some organics could biodegrade over the long term.	Could be implemented. Legal issues could cause long delays.	Low	Retained
Containment	Capping	Flexible membrane liners (FML)	Effective at preventing precipitation from infiltrating the area of soil contamination. Subject to deterioration over the long term.	Capping is a proven technology that is readily available. Long-term maintenance required.	Medium	Screened (Cost)
		Low-permeability soils	Effective at reducing precipitation from infiltrating the area of soil contamination.	Low permeability soil capping is readily implementable. Long term maintenance required.	Low	Retained
		Composite liners	Effective at reducing precipitation from infiltrating the area of soil contamination.	Consists of a combination of FML and low-permeability soils. Long term maintenance required.	High	Screened (Cost)
	Surface controls	- Regrading - Revegetation - Diversion - Collection ditches - Sedimentation basins	Reduces or eliminates surface water runon to the contaminated ares, promotes surface water runoff, and reduces infiltration of water into the subsurface.	Conventional engineering and construction techniques are used. Often used in conjunction with capping. Long term maintenance required.	Low	Retained
Treatment	*In situ*: Physical/Chemical	Soil vapor extraction	For removal of VOCs in soil, and is safer than excavation and disposal. High soil moisture contents and glacial till reduce effectiveness.	Technology is readily available. May be difficult to implement for contaminated soils under landfill and pond.	Medium	Screened (Effectiveness)

Table II.7. (page 2 of 2)

General Response Action	Remedial Technology Type	Technology Process Option	Effectiveness	Implementability	Cost	Screening Results
		Pneumatic fracturing	Increases permeability of low permeability zones. May allow for vapor extraction underneath landfill.	Technology is somewhat innovative. Presence of landfill may not be significant inhibiting factor. However, could cause ground heave and uncontrolled fractures under some conditions.	Low	Screened (Effectiveness)

Table II.8. Selection of Representative Process Options for Groundwater Medium

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
No action	No additional action	No action	Will not attain preliminary remediation goals in near future. Some biodegradation of organics may occur over the long term.	Consideration required by National Contingency Plan. Easily implementable.	N/A	Retained
Institutional controls	Monitoring	Long-term groundwater monitoring	Will not attain preliminary remediation goals in near future. Some biodegradation of organics may occur over the long term.	Can be readily implemented.	Low	Retained
	Access Restriction	Access Restriction	Limits future exposure of human receptors to immobile site contaminants. Does not reduce toxicity, mobility, or volume of contaminants.	Can be implemented. Legal issues and land acquisitions could cause long delays.	Low	Retained
Containment	Vertical barriers	Slurry wall	Effective method of reducing groundwater flow.	Conventional construction techniques. May require sheet piling for steep slopes. Requires the treatment or disposal of excess contaminated soil and slurry. Requires long-term maintenance and monitoring.	Medium	Screened (Implementability)
		Slurry columns	Effective method of reducing groundwater flow.	Conventional construction techniques. No soil excavation required. Requires long-term maintenance and monitoring.	Medium	Retained

Table II.8. (page 2 of 4)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
		Sealable sheet piling	Effective method of reducing groundwater flow.	Installation is relatively clean and rapid. Presence of glacial till may slow installation. Less site disruption and worker exposure during construction.	High	Screened (Effectiveness and Cost)
Collection	Vertical systems	Pumping well system	Effective capture zones can be created to intercept and extract groundwater for treatment.	Readily implementable using conventional techniques. Long term maintenance is required.	Low	Retained
	Horizontal systems	Trench collection system	Can effectively capture groundwater for extraction and treatment.	Implementable at the site. Conventional construction techniques are used. Excavation of contaminated soil would be required. Long term maintenance is required.	Medium	Screened (Cost)
		Horizontal well system	Can effectively capture groundwater for extraction and treatment.	Uses proven drilling techniques to drill horizontal wells. May be difficult in glacial outwash.	High	Screened (Implementability)
Treatment	*In situ*: Physical/Chemical	Permeable treatment wall	Effective at removal of halogenated organics and removal of some heavy metals. However, this technology has not been demonstrated in large-scale remediation designs.	Conventional techniques are used. Implementability is dependent on bench-scale and pilot-scale tests to determine appropriate design.	Medium	Retained

Table II.8. (page 3 of 4)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
		Air sparging	Effective at removing volatile organics from groundwater and the unsaturated zone. This technology would not be effective at removing metals or radionuclides from groundwater.	Readily implementable at OU-1, except that the landfill and overflow pond present obstacles to air injection and extraction. Would require numerous wells through the landfill to deliver air to the aquifer.	High	Screened (Implementability and Cost)
	Onsite: Chemical/Physical	Air stripping	Economical and effective technology for removal of VOCs from water.	Air stripping is an easily implementable technology. Many different designs of air strippers are sold pre-assembled.	Low	Retained
		Cascade aerator	Effective at removing volatile organics from groundwater. Can handle large variations in flow.	Easily implemented. Does not have the same power demands as other types of aerators used for stripping.	Low	Retained
		High-energy electron beam	Effective at destruction of halogenated VOCs. Does not treat inorganics.	Difficult to implement. Innovative technology requires highly trained personnel.	High	Screened (Implementability)
		UV/oxidation	primarily for chlorinated hydrocarbons.	Unreacted contaminants or partially oxidized residuals in the effluent may require additional treatment.	Medium	Retained
	Offsite treatment	Offsite facility	Effective for meeting PRGs	Pretreatment may be required.	High	Screened (Cost)

Table II.8. (page 4 of 4)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
Disposal of treated groundwater	Onsite	Infiltration gallery	Effective for the disposal of treated water. French drains may divert infiltrating water into pond.	An infiltration gallery consists of a trench designed to recharge the surficial aquifer. This process option will allow recharge the upper portion of the aquifer, which may enhance the efficiency of the groundwater collection systems such as the pumping well system.	Medium	Screened Effectiveness)
	Offsite	NPDES Outfall	Effective for the disposal of treated water	Easily implemented. Requires permit modification	Low	Retained
		Offsite facility	Effective for the disposal of treated water	Groundwater is containerized and shipped to approved facility.	Medium	Screened (Cost)
Disposal of treatment residuals:	Offsite	Landfill	Effective for disposal of treatment residuals	Land ban restriction may apply to some constituents. May contain metals and radionuclides. May require pretreatment of residuals.	High	Retained

COCs - contaminants of concern
TCE - trichloroethene
UV - ultraviolet
VOC - volatile organic compound

Table II.9. Process Options Selected for Soil and Groundwater Media

General Response Action	Remedial Technology Type	Technology Process Option	Effectiveness	Implementability	Cost
No action	No additional action	No action	Will not result in the attainment of the *preliminary remediation goals in the* foreseeable future.	Consideration required by National Contingency Plan. Could be readily implemented.	N/A
Institutional	Monitoring	Long-term monitoring of contamination	Will not result in the attainment of the preliminary remediation goals in the foreseeable future.	Can be readily implemented.	Low
	Access restriction	Access Restriction	No near term reduction in toxicity, mobility, or volume of contaminants. Some organics could biodegrade over the long term.	Could be implemented. Legal issues could cause long delays.	Low
Containment	Capping	Low-permeability soils	Effective at reducing precipitation from infiltrating the area of soil contamination.	Low permeability soil capping is readily implementable. Long term maintenance required.	Low
	Surface controls	- Regrading - Revegetation - Diversion - Collection ditches - Sedimentation basins	Reduces or eliminates surface water runon to the contaminated ares, promotes surface water runoff, and reduces infiltration of water into the subsurface.	Conventional engineering and construction techniques are used. Often used in conjunction with capping. Long term maintenance required.	Low
Treatment	*In situ*: Physical/Chemical	Soil vapor extraction	For removal of VOCs in soil, and is safer than excavation and disposal. High soil moisture contents and glacial till reduce effectiveness.	Technology is readily available. May be difficult to implement for contaminated soils under landfill and pond.	Medium
No action	No additional action	No action	Will not attain preliminary remediation goals in near future. Some biodegradation of organics may occur over the long term.	Consideration required by National Contingency Plan. Easily implementable.	N/A
Institutional controls	Monitoring	Long-term groundwater monitoring	Will not attain preliminary remediation goals in near future. Some biodegradation of organics may occur over the long term.	Can be readily implemented.	Low

Table II.9. (page 2 of 2)

General Response Action	Remedial Technology Type	Technology Process Option	Effectiveness	Implementability	Cost
Institutional controls	Access Restriction	Access Restriction	Limits future exposure of human receptors to immobile site contaminants. Does not reduce toxicity, mobility, or volume of contaminants.	Can be implemented. Legal issues and land acquisitions could cause long delays.	Low
Containment	Vertical barriers	Slurry columns	Effective method of reducing groundwater flow.	Conventional construction techniques. No soil excavation required. Requires long-term maintenance and monitoring.	Medium
Collection	Vertical systems	Pumping well system	Effective capture zones can be created to intercept and extract groundwater for treatment.	Readily implementable using conventional techniques. Long term maintenance is required.	Low
Treatment	*In situ*: Physical/Chemical	Permeable treatment wall	Effective at removal of halogenated organics and removal of some heavy metals. However, this technology has not been demonstrated in large-scale remediation designs.	Conventional techniques are used. Implementability is dependent on bench-scale and pilot-scale tests to determine appropriate design.	Medium
	Onsite: Chemical/Physical	Air stripping	Economical and effective technology for removal of VOCs from water.	Air stripping is an easily implementable technology. Many different designs of air strippers are sold pre-assembled.	Low
		UV/oxidation	primarily for chlorinated hydrocarbons.	Unreacted contaminants or partially oxidized residuals in the effluent may require additional treatment.	Medium
Disposal of treated groundwater:	Offsite	NPDES Outfall	Effective for the disposal of treated water	Easily implemented. Requires permit modification	Low

COCs - contaminants of concern
TCE - trichloroethene
UV - ultraviolet
VOC - volatile organic compound

Effectiveness

As with the no-action alternative, institutional actions do not address or remediate the contaminants at the site or meet the remedial action objectives except by limiting future exposure of human receptors to immobile site contaminants. They do not reduce the toxicity, mobility, or volume of contaminants.

Implementability

This option can be readily implemented.

Cost

The cost of implementing institutional action is minimal. However, substantial costs could arise from legal fees and compensation paid to affected property owners if the plume moves offsite.

Containment Actions: Capping

Most of the areas where contaminated soils may exist at the site are covered by the site sanitary landfill cap or by the overflow pond. Capping, therefore, would consist of augmenting the site sanitary landfill cap along its perimeter to cover areas where former trenches existed or where waste disposal may have occurred in the past. The primary purpose in augmenting the existing cap is to extend control of surface water flow and infiltration over an area slightly larger than that offered by the existing cap. The technology chosen for this purpose must not be disruptive of the current cap and must be reasonable to construct, considering, among other things, the steep sides of the existing cap. Therefore, the technology selected is the type that most closely resembles the existing cap. In areas where the slope of the augmented cover will not be so steep as to preclude the construction of a multilayer cap, a 1-ft drainage layer may be incorporated into the cover design, per OAC 3745-27-11. If this process option is selected as part of the approved remedy, the final design would be determined in the remedial design phase. Containment actions for the soil medium would utilize the capping technology described.

Effectiveness

Infiltration of precipitation through unsaturated, contaminated soils can cause contaminants to be leached into the groundwater. A properly designed and constructed cap made of low-permeability materials is effective in minimizing infiltration by maximizing runoff during rainstorms. When the flux

rate of contaminants entering the groundwater is reduced, groundwater concentrations decrease. The VOCs in the soil medium should eventually biodegrade in place, and the metals should essentially become immobilized. The overall effect shortens remediation time.

Implementability

Capping is a proven technology that is readily available; however, some difficulties do exist. Installation of the flexible membrane liner (FML)-type cap can be difficult, and the FML can be damaged by weather, human activity, and animals unless covered by a protective layer. Low-permeability soil caps are the easiest to install, but they are susceptible to desiccation cracks and usually require an erosion layer on top of the soil liner. A composite liner cap shares the problems of both the FML-type cap and the soil cap because it comprises elements of both designs. The low-permeability cap more closely resembles the technology type used for the existing cap and would be the easiest with which to augment the existing cap, given the steep sides.

Cost

The low-permeability soil liner is the lowest cost liner of this type available because of the ease of installation and the low cost of materials. The FML liner is of moderate cost, and the composite liner cost is ranked as high.

Containment Actions: Surface Controls

Regrading, revegetation, diversion, and creation of collection ditches and sedimentation basins make up the technology type of surface controls. The purpose of these controls is to divert surface water runon, enhance surface water runoff, and minimize the potential for erosion. Implementing this technology consists of augmenting the existing surface control features (e.g, drainage control, diversion, collection) to protect the entire area of contamination.

Effectiveness

Controlling the surface water through the previously mentioned options reduces or eliminates surface water runon to the contaminated areas, promotes surface water runoff, and reduces infiltration of water into the subsurface. As with capping, surface-water control minimizes contaminant transport to the groundwater via the unsaturated, contaminated soils. Also, sedimentation basins minimize the transport of contaminated sediment away from the site.

Implementability

These readily available process options use conventional engineering and construction techniques, and are often used in conjunction with other technologies such as capping.

Cost

The costs are relatively low for these options.

***In situ* Treatment: Soil Vapor Extraction**

This process removes VOCs and some semivolatile organic compounds from unsaturated soils by withdrawing organic vapors under negative pressure through extraction wells. A vapor/liquid separator is installed in the treatment train to remove entrained water or condensate. The vapors are typically treated using carbon adsorption, thermal destruction, or condensation.

Demonstrations have shown that soil vapor extraction can be enhanced by the use of increased natural biological activity or heated air. In theory, the addition of the hot-gas injection raises contaminant temperature and increases contaminant vapor pressure. Contaminant mass transport rates are thereby increased compared to those of conventional technology not using hot gas injection.

Effectiveness

Soil vapor extraction may provide effective source control of VOCs in soil and is usually safer and more cost-effective than excavation and disposal. Soil vapor extraction is most effective at removing compounds that have high vapor pressure and exhibit significant volatility at ambient temperatures in contaminated soil. Compounds exhibiting vapor pressures over 0.5 millimeters (mm) of mercury, such as vinyl chloride, TCE, trichloroethane (TCA), and tetrachloroethene (PCE), can most readily be extracted. Soil vapor extraction, however, is not expected to be effective for low-volatility organics such as PCBs, pesticides, dioxins/furans, or inorganics such as radioactive materials and metals. The presence of glacial till in the unsaturated zone may reduce air flow due to the lower permeability of the fill. High soil moisture content also reduces effectiveness.

Implementability

Based on accessibility, it would be difficult to implement this option to treat unsaturated, contaminated soils under the site sanitary landfill and the overflow pond. Also, soil characteristics such as site stratigraphy, porosity and permeability, high clay or humic content, soil temperature, heterogeneity, and buried debris can have a significant effect on this option. Treatment residuals produced from the application include condensate (in this case, contaminated water and possibly supernatant organics) and possibly spent granular-activated carbon if used for off-gas treatment. The existing cap along with cap improvements will help provide a surface seal at the site, which will improve contaminant extraction rates. Injection and extraction wells would be installed by drilling through the site sanitary landfill, requiring surface casing to protect the landfill integrity and additional earth work to support the drilling rig.

Cost

Designing and implementing a soil vapor extraction system is relatively more costly than surface controls and capping. Overall, it is considered a medium-cost option if implemented on a large scale.

***In situ* Treatment: Pneumatic Fracturing and Hot Gas Injection**

Pneumatic fracturing extraction is used to increase subsurface air flow within low permeability formations. As previously discussed, the presence of the glacial till may reduce air flow in the vadose zone. Pneumatic fracturing can be used to enhance contaminant mass removal by using techniques such as soil vapor extraction or hot gas injection. For the latter technique, hot gas is injected under pressure to increase temperatures and volatilize organic contaminants, and the organic vapors are extracted and treated.

Effectiveness

Pneumatic fracturing increases the permeability of low permeability zones, thereby increasing air extraction flow rates of soil vapor extraction systems. Better subsurface air flow allows contaminants to volatilize, and they can then be removed faster than with conventional technology.

Implementability

Because formation permeability and vacuum radius of influence is increased under the pneumatic fracturing option, fewer wells are spaced at greater distances. During the fracture events, ground

heave usually occurs and could compromise the landfill. A more important issue, however, is that unwanted fractures may propagate and effect the integrity of the site sanitary landfill.

Cost

The cost of this option is low because it is usually done only once.

2.3.2.2. Screening of Technology Process Options for Groundwater Medium

No Action

Under the no-action alternative, no further remedial action would take place at the site. Current contamination would be left in place, and the only changes in contaminant levels would be those resulting from natural processes.

Effectiveness

The no-action option will not result in the attainment of the preliminary remediation goals, and it is not likely to result in significant reduction of health risks within the foreseeable future. Some degradation of organics may occur over time by natural processes such as biodegradation. The no-action option may not achieve remedial objectives; however, it is required by the NCP and is retained as a basis for comparison with other alternatives.

Implementability

Implementability is not an issue with the no-action alternative as it involves no action.

Cost

The no-action alternative involves no cost.

Institutional Action: Long-term Monitoring and Access Restriction

Restricted access and long-term monitoring are institutional actions. Future groundwater data would be used to determine if additional contaminants were migrating away from the area of contamination.

Restricted access by such means as fencing, creates a physical barrier to prevent human access to Area B.

Effectiveness

As with the no-action option, institutional actions do not address or remediate the contaminants at the site or meet the remedial action objectives except by limiting future exposure of human receptors to immobile site contaminants. Such actions do not reduce the toxicity, mobility, or volume of contaminants.

Implementability

This option can be implemented, but resolution of legal issues such as enforcing deed restrictions on offsite groundwater use could cause long delays.

Cost

The cost of this option is minimal.

Containment: Slurry Wall

A slurry wall is constructed by excavating a vertical trench and simultaneously backfilling it with a slurry. The trench is as deep as 50 ft in this case so that the slurry wall can be keyed into bedrock. The wall would be installed along the western and southern perimeter of the landfill away from known areas of soil contamination. The slurry wall requires less maintenance compared to other containment technologies such as the pumping well system.

The slurry is a mixture consisting of soil, bentonite, and water. The slurry in the trench helps prevent collapse during excavation and provides a low permeability barrier to control the lateral migration of contaminated groundwater.

Effectiveness

Slurry walls are recognized as an effective method of reducing subsurface groundwater flow and are well-suited for remedial applications. Permeabilities of less than 1×10^{-6} centimeters per second (cm/s) are normally obtained. Potential for worker exposure to COCs exists during construction because of the removal, mixing, and backfilling of soils that may be contaminated.

Implementability

The slurry wall is applicable only to sites that are graded nearly level. Within Operable Unit 1, some areas around the landfill vary in topography. The trench line of the wall must be within a few degrees of level. If the topography varies much from horizontal, sheet piling placed to span the trench may be used to create a terrace-type construction.

Construction of the slurry wall requires a large staging area for soil mixing, which is not a problem if an area outside Operable Unit 1 can be used. Because this option requires the treatment or disposal of excess contaminated soil and slurry, it is not as implementable as the slurry column options described below.

Cost

Usually, the slurry wall option is a low-cost method of containment; however, additional sheet piling for terracing and site grading make the option overall a medium-cost process.

Containment: Slurry Columns

Slurry columns form a vertical barrier similar to the slurry wall. They would be installed along the western and southern perimeter of the landfill away from areas of soil contamination. Construction of slurry columns involves augering through the subsurface with specialized drilling equipment consisting of a row of closely-spaced augers suspended from a crane. As the augers advance to the desired depth, bentonite is added through the center of the augers and is mixed with the soil being penetrated. The soil is mixed again as the augers are withdrawn, and a low permeability barrier is formed.

Effectiveness

As with slurry walls, slurry columns keyed into bedrock are an effective method of reducing groundwater flow in the subsurface and are well-suited for the conditions at Operable Unit 1. Using this option, sufficiently low permeabilities are normally obtained. The potential for exposure of the worker to COCs during construction is less than that of the slurry wall because the soil mixing is done in place.

Implementability

Slurry columns do not require the direct excavation of any soil during construction. Compared to a conventional slurry wall, this option generates a much smaller volume of potentially contaminated soils. The equipment used to construct the slurry columns has been used at other sites to reach depths in excess of 50 ft. Fifty feet is the maximum depth to bedrock at Operable Unit 1.

Cost

The cost of slurry columns is medium compared to the usually low cost of a slurry wall.

Containment: Sealable Sheet Piling

Sealable sheet piling is a type of vertical barrier developed at the University of Waterloo Institute for Groundwater Research. The sheet piling is driven into the ground using conventional installation methods, and the joints interlock to form a cavity. The cavity is inspected and filled with a sealant to form an impermeable barrier.

Effectiveness

As with the other vertical barriers considered for Operable Unit 1, this process option would be effective alone as a containment barrier. It can also be used in combination with other technology types such as pump-and-treat options or *in situ* treatment such as the permeable treatment bed described later in this subsection. As with the slurry column option, the potential for exposure of the worker to COCs during construction is less than that of the slurry wall because little or no soils are excavated. However, it would be difficult to drive the sheet piling into bedrock to provide an effective seal.

Implementability

Because excavation of the subsurface material is not required, less damage to the site and disruption of normal site activities results from sheet piling. Because workers are not exposed to contamination, health and safety precautions can also be reduced, and disposal of large volumes of contaminated soil is avoided. Installation is relatively clean and rapid. However, the presence of glacial till may slow installation due to the fine grain sizes causing a slower penetration rate. Corners and irregular geometries are easily constructed, and topography and depth have little effect on installation techniques.

Cost

The cost of sealable sheet piling is relatively high compared to other containment techniques such as slurry walls and slurry columns.

Containment/Extraction: Pumping Well System

Groundwater collection and extraction using a pumping well system requires a series of wells installed at the site. Each well is individually equipped with dedicated pumps. The combined influence of the wells intercepts the flow of contaminated groundwater within the area defined as the capture zone. Groundwater flow direction and withdrawal rates are also controlled by the well pumps. The groundwater pumped to the surface is treated before disposal.

Effectiveness

Preliminary modeling suggests that two wells screened in the unconsolidated sediments at the Site would create an effective capture zone to encompass the contaminated portions of Operable Unit 1. These wells would be placed in the western part of the site and would extract contaminated groundwater for treatment and would create a hydraulic barrier to prevent contaminant migration offsite. During remediation water levels would be monitored to ensure that adequate capture zones are formed.

Implementability

Pumping well systems are easily implementable and can operated in a variety of Site conditions. Many groundwater monitoring wells have been installed at the Site, and groundwater production wells have been installed and are operating at the Site. Therefore, no extraordinary problems of implementability are expected.

Cost

The cost of design and implementation of a pumping well system is relatively low. The costs of water treatment systems that would be used in conjunction with extraction wells will be discussed later.

Containment/Extraction: Trench Collection System

A trench collection system is a subsurface drain system used to collect and extract groundwater. The system includes sumps and lift pumps to extract the water from below the ground surface. This type of extraction system acts as a continuous line of pumping wells to create a line sink.

Effectiveness

Although a pumping-well system is more adaptable to unforeseen changes in subsurface conditions, a trench collection system is a proven and reliable technology that can provide the control needed to effectively capture groundwater. As with the pumping-well system, the trench would be placed west and south of the site sanitary landfill and would extract contaminated groundwater for treatment as well as create a hydraulic barrier to prevent contaminant migration. During remediation water levels would be monitored to ensure that an adequate hydraulic barrier is formed.

Implementability

A trench collection system installation is implementable at the Site. Conventional construction techniques would be used. However, excavation of soil would be required, which increases the potential exposure of workers to COCs during construction. Dewatering is required for some types of trench installation. The conventional dewatering technique for trench installation uses well points that are effective only to depths of 20 ft below ground surface. Dewatering to about 35 ft below ground surface would be required. Sheet piling could be used during trenching, but it is covered as a previously discussed process option (sealable sheet piling).

Cost

Because of the 30-ft depth required for this option, the cost of a trench collection system would be medium compared to other extraction technologies.

Containment/Extraction: Horizontal Well System

Horizontal wells and directional drilling techniques were originally developed by the petroleum industry. These wells have been successfully drilled and completed in unconsolidated sediments using short-radius, mud-rotary drilling tools. Other techniques have been developed for geotechnical and environmental projects. Currently, research is being conducted in the use of horizontal wells for bioremediation and vapor extraction techniques.

Effectiveness

Like the trench system, the horizontal well would be completed west of the western boundary of the site sanitary landfill, trending north to south, and would extract contaminated groundwater for treatment as well as create a hydraulic barrier to prevent contaminant migration. Water levels would be monitored to ensure that an adequate hydraulic barrier is formed. However, it is not clear if current techniques would allow for the horizontal well system to be installed adjacent to the site sanitary landfill because of the sharp angles required and close clearance (15 ft) to bedrock.

Implementability

The overall horizontal well drilling performance is controlled by geologic conditions (percentage of fines), rigid drill mandrel configuration, drilling bit speed and weight, and drilling fluid pumping rates. Preferred target zones for optimal drilling performance contain minor amounts of clay, which improves the competency of the formation. Because the contaminated groundwater is contained mostly within unconsolidated glacial outwash, a horizontal well would be very difficult to construct.

Cost

The cost of design and installation of a horizontal well in glacial outwash is high compared to conventional extraction wells or collection trenches.

***In situ* Treatment: Permeable Treatment Walls**

Treatment walls are trenches excavated perpendicular to the groundwater flow direction and backfilled with a reactor material. Groundwater barriers (such as slurry walls or sealable sheet piling) are used to direct the flow of all contaminated groundwater into the treatment wall. The permeable material treats contaminated groundwater as it flows through the trench. The treatment materials can include an iron-based reactor material, limestone, carbon, or glauconite. The limestone and glauconite treatment materials are for removal of heavy metals. The iron-based reactor material and carbon material is used for removal of organic contaminants.

Effectiveness

Results of laboratory tests and pilot-scale field tests using treatment walls have shown significant removal of halogenated organics, which would be effective for the VOCs at Operable Unit 1. However, this technology has not been demonstrated in large-scale remediation designs. Limitations include

possible saturation or plugging of the treatment material due to inorganic mineral precipitation over long-term operation.

Implementability

Conventional techniques are used in the construction of permeable treatment walls. Site conditions at Operable Unit 1 should not present any installation difficulties other than those already described for sealable sheet piling and slurry walls. Implementability is dependent on bench-scale and pilot-scale tests to determine appropriate reactor material and dimensions of system.

Cost

The costs of construction and materials for this technology are relatively less than groundwater extraction including an aboveground treatment train. About half of the cost is the reaction material. However, costs will also be incurred from laboratory tests and possible pilot-scale tests to identify the appropriate treatment material and system maintenance in the form of reactor material replacement if needed.

***In situ* Treatment: Air Sparging**

Air sparging forces air into the aquifer, causing volatilization of VOCs. The air-sparging system consists of an array of injection and extraction wells. Vapor extraction-wells are located above the water table. Vacuum pumps are used to extract contaminant vapors through the wells. The injection wells are located below the water table to create air movement through the contaminated groundwater, which causes *in-situ* air stripping of the VOCs.

Effectiveness

Air sparging is effective for removing VOCs, such as TCE and other COCs, from groundwater and the unsaturated zone at Operable Unit 1. The till in the unsaturated zone, however, may reduce air flow due to its lower permeability. If required, the extracted vapor could be treated before release into the atmosphere.

Implementability

Air sparging technology has been utilized at a number of sites and can be implemented at Operable Unit 1. However, the site sanitary landfill and overflow pond present obstacles to air injection and

extraction because of the lower permeability of the glacial till. To treat the entire aquifer, it may be necessary to install numerous air injection points at closely spaced intervals (approximately 30 ft centers). This installation may involve grading the cap in certain places to allow placement of drilling machinery on top of the landfill. Also, surface casing would have to be installed through the landfill at each point of entry to ensure the integrity of the cap and liner.

Cost

The cost of air sparging would be relatively high because of the large number of sparging wells and extraction wells needed.

Onsite Treatment: Air Stripping

Air stripping is a mass transfer process whereby VOCs are removed from liquids, such as extracted groundwater, by forcing air under pressure through the liquid. Air stripping is commonly performed onsite using a packed tower that works on the principle of countercurrent flow. The contaminated water flows downward through the packing while the air flows upward and is exhausted through the top. Other types of air strippers include the low profile tray and multi-cell air stripper. These units diffuse air through a chamber of flowing water to achieve the mass transfer process. The VOCs are then transferred from the liquid phase to the gaseous phase, and the vapors can be vented from the air stripping unit. Emission control devices may be required to remove the contaminants from the airstream. Potential air-emission control devices include a vapor phase granular activated carbon oxidizer and a catalytic oxidizer.

Effectiveness

Air stripping is an effective, and usually economical, technology for removal of VOCs from water.

Implementability

Air stripping is an easily implementable technology. Many different designs of air strippers are sold pre-assembled. Effluent (vapor) treatment technologies are also readily available. The use of air stripping trays preclude the use of pretreatment for iron and magnesium removal. The addition of vapor treatment requirements, however, detract from the simplicity of the treatment train.

Cost

The cost of air stripping technology is relatively low compared to other technologies for removal of VOCs.

Onsite Treatment: Cascade Aerator

Cascade aeration is a simple process option used to remove VOCs from water. The groundwater is pumped to the top of an inclined plane, where it cascades by gravity down a transversely corrugated surface. The resulting turbulence enhances the mass exchange of dissolved VOCs from the water to the gas phase. If needed, this system can be fitted with a vapor phase treatment system like that described for the air stripping treatment unit.

Effectiveness

Cascade aeration is an effective, usually economical technology for the removal of VOCs from water.

Implementability

Cascade aeration is an easily implementable technology. Many different configurations (e.g., ramp length and width, and inclination angle) can be constructed. Pretreatment of the water to remove inorganics, such as iron and magnesium, is not needed. The addition of vapor treatment requirements, however, detract form the simplicity of this process option.

Cost

The cost of the cascade aerator is low compared to other technologies for removal of VOCs.

Onsite Treatment: High-Energy Electron Beam

This technology uses a high-energy electron beam to destroy hazardous constituents in groundwater. The beam is created by a 1.5 megaelectron volt (MeV) electron accelerator. The electrons pass through a thin window and strike contaminated water that falls in a thin sheet from a weir. The beam ionizes the water and forms hydroxyl radicals, aqueous electrons, and hydrogen radicals, all of which decompose the organic compounds and bacteria in the water.

Effectiveness

The high-energy electron beam is effective for the destruction of halogenated hydrocarbons through oxidation and reduction. No chemical pretreatment is required, and no residuals are generated.

Implementability

The high-energy electron beam process option can be implemented as a portable unit or in a permanent structure. In either case, specially trained personnel would be required to operate and maintain the equipment. Because an electron accelerator is required, hazards to operators exist throughout the operation of the unit. The portable technology has not been demonstrated yet.

Cost

Even though disposal costs are eliminated with this process, the high energy usage, specialized equipment, and trained personnel requirements cause this option to be classified as high cost.

Onsite Treatment: UV/Oxidation

Ultra violet (UV)/oxidation treatment involves the use of ozone or hydrogen peroxide, and ultraviolet light to photo-oxidize organic contaminants. Groundwater is pumped into holding tanks and hydrogen peroxide is added to begin destruction of the organics. Ozone is generated in the UV/oxidation tanks. Ultimately, the VOCs are destroyed, resulting in carbon dioxide, water, and halide ions. Unreacted contaminants or partially oxidized residuals in the aqueous effluent may require additional treatment in the unit. The system provides emission control for hydrogen chloride generated during this process.

Effectiveness

The UV/oxidation process option is suitable for destroying organic compounds dissolved in groundwater, including chlorinated hydrocarbons, such as TCE, found at Operable Unit 1. The effectiveness of this option can be reduced by high concentrations of iron, manganese, and suspended solids. However, analytical data does not indicate that this is a concern for this technology.

Implementability

This process option is easily implemented at the site. A small utility-type building can be used to house the equipment. Training of personnel and initial monitoring of the equipment are required at the beginning of implementation.

Cost

The cost category of this process option is medium.

Offsite Treatment and Disposal

Under this process option, contaminated groundwater is containerized and transported to an approved treatment facility. The treated water is disposed of at an approved facility.

Effectiveness

This is an effective method for meeting the PRGs.

Implementability

If the groundwater is a mixed waste, either it is pretreated to remove the hazardous waste components, thus reducing it to a radioactive waste, or it is handled as a mixed waste. Many public safety concerns are associated with shipment of these wastes.

Cost

The cost of treating the hazardous waste components of the groundwater or handling the groundwater as a radioactive or mixed waste is high.

Onsite Disposal: Infiltration Gallery

An infiltration gallery consists of a trench designed to recharge the surficial aquifer. A trench is excavated and the base is backfilled with coarse sand or gravel to increase infiltration rates. A benefit of this technology is that a hydraulic barrier in the form of a mound will be created that can redirect

groundwater flow. Alternatively, water can be recharged to increase flux through the zone of contamination and to flush out materials.

Effectiveness

This process option can be effective for disposal of treated groundwater. However, because of the presence of french drains beneath the landfill, the infiltrating water could be diverted away from the contaminated areas. This would negate any intended benefit of recharging water to enhance cleanup.

Implementability

An infiltration gallery can be constructed with conventional techniques.

Cost

The cost of an infiltration gallery is medium.

Offsite Disposal: NPDES - permitted outfall

Effectiveness

This involves modifying the current Mound Plant National Pollutant Discharge Elimination System (NPDES) permit to include the discharge of groundwater from Operable Unit 1 remediation activities. This process is effective for the disposal of water. The volume of the anticipated discharge is inconsequential in comparison to the low flow of the river (223 million gallons per day in 1991). The anticipated water quality impacts will be evaluated in Section 4.

Implementability

This option can be implemented at the site provided quality is adequate to meet NPDES requirements.

Cost

The cost associated with this process option includes modification of the permit and minor equipment changes and is in the category of low.

Offsite Disposal: Treatment Residuals

Disposal of the residuals associated with pretreatment process options can be accomplished at an approved offsite facility. Future liabilities associated with any offsite disposal activity must be considered prior to implementing this process option. It is likely, however, that the treatment residuals from the UV/oxidation process (salts) can be disposed of in a municipal solid waste landfill.

2.4. PROCESS OPTIONS SELECTED FOR SOIL AND GROUNDWATER

The previously discussed process options and technology types that have been selected for further investigation are shown in Table II.9. In Section 3, the technology types and process options are combined into remedial action alternatives and evaluated in more detail.

3. DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1. COMBINATION OF TECHNOLOGIES INTO ALTERNATIVES

In this stage of the feasibility study, general response actions and the technology types for both soil and groundwater are combined to form remedial action alternatives appropriate for evaluation. The process options that have been identified and retained, as discussed in Section 2, have been assembled into twelve alternatives. A wide range of alternatives are considered from limited action to collection, treatment, and disposal. The general response action and technology types that comprise each alternative are indicated in Table III.1. A single technology is selected from two or more that were retained (Section 2). Technology evaluation is based on 1) effectiveness in meeting the remedial action objectives, 2) implementability on the basis of engineering constraints and site-specific criteria, and 3) estimated cost.

The effectiveness of an alternative was measured in terms of protection of human health and the environment and the reductions in contaminant toxicity, mobility, or volume. Both the short-term (i.e., during construction) and long-term (i.e., after the remedial action is complete) components of effectiveness are evaluated.

The implementability of an alternative was measured by the technical and administrative feasibility of constructing, operating, and maintaining the alternative. Technical feasibility includes the ability to construct, reliably operate, and meet technology-specific regulations during the life of the alternative. Administrative feasibility includes the ability to obtain approvals from other offices and agencies, storage and disposal capacities, and specific equipment and technical specialists.

Cost estimates for a particular technology alternative were determined using either vendor-supplied unit costs for specialty technologies and the Cost of Remedial Action (CORA) estimator for the commonly used options (EPA 1990b). The CORA model is designed for the development of order-of-magnitude cost estimates. As specified by the FFA, the cost estimates were compared to the EPA Compendium of Cost of Remedial Technologies at Hazardous Waste Sites, where possible (EPA 1987). In this section, estimates were developed for the capital costs and for first-year O&M only. Long-term O&M cost estimates are presented in detail in Section 4.

Capital cost estimates by CORA combine labor, material, equipment, testing and monitoring, health and safety, and utility costs into one technology construction cost. Estimates for mechanical, electrical, instrumentation and control costs are calculated by CORA using percentages. For first-year O&M costs, labor is based on standard labor rates as updated in 1993. Maintenance is added as a

Table III.1. Alternatives Array for Mound Plant Feasibility Study

General Response Action			1	2	3	4	5	6	7	8	9	10	11	12
Medium	Technology Type	Area or Volume	No Action	Instit-utional	Collect Disposal	Surface Cap Collect Disposal	Collect Treat Disposal	Surface Cap Collect Treat Disposal	Contain Collect Disposal	Surface Cap Contain Collect Disposal	Contain Collect Treat Disposal	Surface cap Contain Collect Treat Disposal	*In Situ* Ground-water Treatment	Surface Cap + *In situ* Ground-water Treatment
Soil and Ground-water	Monitoring	entire site		●	●	●	●	●	●	●	●	●	●	●
	Access Restriction	entire site		●	●	●	●	●	●	●	●	●	●	●
Soil	Surface Controls	entire site			●	●	●	●	●	●	●	●	●	●
	Surface Capping	part of site				●		●		●		●		●
Ground-water	Subsurface Barriers	entire site							●	●	●	●		
	Extraction	entire site			●	●	●	●	●	●	●	●		
	Above-ground Treatment[a]	all water					●	●			●	●		
	In situ Treatment[b]	all water											●	●
	Disposal	all water			●	●	●	●	●	●	●	●		

[a] Aboveground groundwater treatment options include air stripping and UV/oxidation
[b] *In situ* groundwater treatment option is the permeable treatment wall.

percentage of the subtotal estimated O&M costs. Site preparation, administration, permitting and legal services are included as indirect costs for both capital and O&M. Appendix D presents the cost estimates for each alternative using the CORA program.

3.2. SCREENING OF ALTERNATIVES

3.2.1. Alternative 1 - No Action

The no-action alternative is retained for comparison and is required by the NCP. It does not involve implementing any options as shown in Table III.1 and therefore is not described in this section.

3.2.2. Alternative 2 - Limited Action

The limited action alternative consists of monitoring soil and groundwater quality with the implementation of institutional controls to limit access to the site (Table III.1). Institutional controls would be designed to prevent land and groundwater use. Such controls could take the form of fencing around the site to minimize contact with soils and deed restrictions to prevent groundwater usage onsite and downgradient.

Effectiveness

Institutional controls would likely prevent exposure to groundwater and most contact with contaminated soil. However, they would not result in compliance with remediation goals. Contaminant toxicity, mobility, or volume for either soil or groundwater would not be significantly reduced. Over the long term, some attenuation of the groundwater contamination is expected from adsorption, degradation, and dilution. The remaining contaminants in the soils and unsaturated zone would continue to act as a source of groundwater contamination.

Implementability

Implementation of institutional controls is possible with appropriate legal actions, public communication, and negotiations with those potentially affected.

Cost

The capital cost for limited action is estimated to be $78,000. The first-year O&M costs are estimated to be $75,000. Additional costs, which could be significant, may include legal fees and compensation to affected property owners and cannot be precisely estimated.

Summary

The limited-action alternative is implementable and could provide some protection. However, this alternative does not reduce the mobility, volume, or toxicity of contamination and consequently does not achieve the PRGs. This alternative was retained for further analysis.

3.2.3. Alternative 3 - Collection and Disposal

In addition to the set of actions discussed in Alternative 2 (monitoring the soil and groundwater quality, implementing access restrictions), the collection-and-disposal alternative also encompasses the construction of surface controls and extraction of groundwater for disposal through the Mound Plant National Pollutants Discharge Elimination System (NPDES)-permitted outfall (Table III.1). Under this alternative, the soil contamination would be left in place with this alternative.

Effectiveness

Surface controls such as grading and lining of existing ditches would manage the runon and runoff and reduce infiltration. Reduction of infiltration would slow the rate at which contaminants migrate from the unsaturated soil into the groundwater.

Groundwater extraction with recovery wells would be effective for capturing contaminated groundwater beneath the site before migration offsite. Site conditions favoring groundwater recovery include high hydraulic conductivities in the glacial outwash, mostly mobile VOCs, and no substantive interbedding of clay or silt layers with the saturated glacial outwash. However, because the source of groundwater contamination would be left in place, subsurface reduction of the contaminant mass would occur over a period of time that is not readily predictable.

The effluent concentrations are expected to be acceptable for discharge to the NPDES-permitted outfall without causing adverse damage to human health and the environment. The discharge, however, will be monitored for the current COCs as well as the occurrence of unanticipated compounds. If the monitoring indicates unacceptable levels in the effluent, a contingency plan will be

implemented. The contingency plan would call for immediate shut-down of the pumping and discharge system and the expeditious design and implementation of a treatment system to address the new compounds or unacceptable levels of COCs.

Capture-zone analytical modeling (Appendix E) shows that two wells with a total extraction rate of 45 gallon per minute (gpm) would create capture zones, which would intercept groundwater moving from Area B and the contaminated groundwater just south of Area B (Figure 3.1). The capture zone would be larger in reality because the average saturated thickness is approximately 12 ft but decreases to zero toward the eastern boundary of Area B (Figure 1.5). Groundwater extraction would effectively reduce the volume of contaminated groundwater. Because pumping creates a hydraulic barrier, groundwater extraction would also effectively decrease offsite migration of contaminated groundwater.

There are uncertainties, however, associated with using of recovery well capture zones to limit the offsite migration of groundwater. The size of the capture zones is influenced by pumping rate variations, hydraulic gradient changes, and direction of groundwater flow. For example, as seasonal groundwater levels increase, the pumping rate would also have to be increased to maintain the same effective capture zone. If adjustments are not made in a timely manner, the potential for offsite flow of contaminated groundwater may result. Therefore, this alternative would require frequent evaluation of system performance with respect to hydraulic gradients and flow directions. Furthermore, if groundwater production wells were established nearby in the Buried Valley aquifer at some time in the future, the effects of their withdrawals could change groundwater flow directions and gradients, resulting in ineffective capture of groundwater contaminants by Area B recovery wells.

If recovery wells are involved in the selected remedy, more sophisticated groundwater modeling would be included in the detail design. This modeling would establish:

- optimum locations for the extraction wells to insure that appropriate, reliable capture zones are established;
- a predicted location for the compliance boundary; and
- appropriate locations for monitoring wells.

<u>Implementability</u>

The technologies associated with this alternative are implementable using conventional construction techniques.

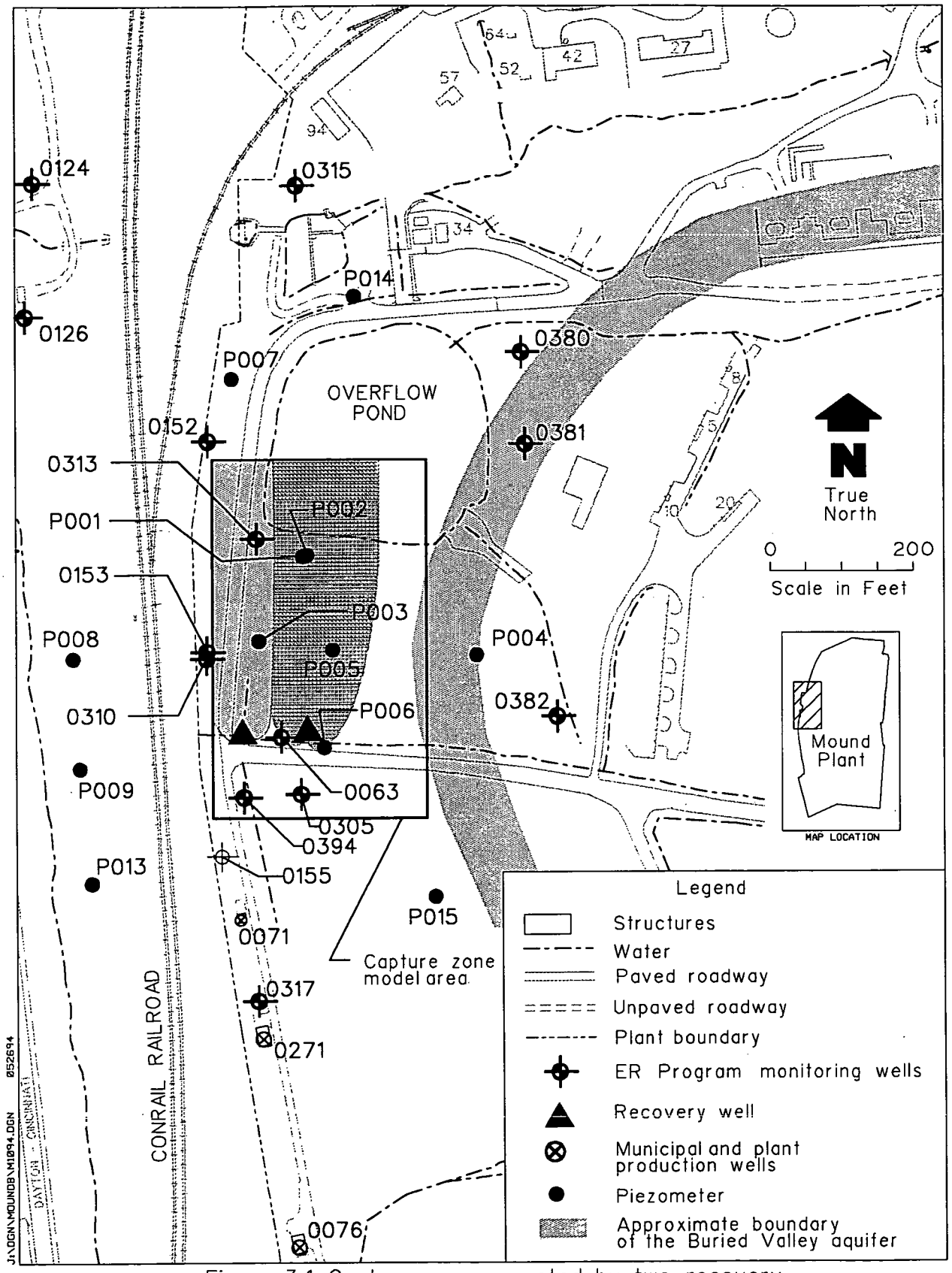


Figure 3.1. Capture zones created by two recovery wells in the Operable Unit 1 area.

Cost

Capital costs are estimated to be $390,000. The first-year O&M costs are estimated to be $90,000.

Summary

The collection-and-disposal alternative would reduce the volume of groundwater contamination and its migration downgradient. For the unsaturated soils, contaminant toxicity or the mobility of contaminants would not be reduced. The source for groundwater contamination would remain active, which would make the time required for contaminated groundwater recovery unpredictable. However, this alternative is retained for further consideration.

3.2.4. Alternative 4 - Surface Capping, Collection, and Disposal

In addition to the set of actions under Alternative 3, Alternative 4 includes the addition of a surface cap (Table III.1) (Figure 3.2). Under Alternative 4, a surface cap of low permeability soil would be placed on the ground surface above known waste disposal areas and any soils that could be considered potential sources of groundwater contamination. The cap design would allow it to be integrated into the existing cap for the site sanitary landfill and surface drainage structures to minimize erosion and infiltration.

Effectiveness

The effectiveness and uncertainties of groundwater collection and disposal were described in Alternative 3. A surface cap of low permeability soils coupled with such surface controls would enhance infiltration reduction. Extending the surface cap would also reduce infiltration into the unsaturated zone. Such a reduction in infiltration would reduce the contaminant flux from the unsaturated zone into the groundwater system. Once equilibrium is established between the groundwater system and the new contaminant flux, concentrations of groundwater contaminants could be less than those without the cap. Hence, a reduction in infiltration ultimately could reduce contaminant concentrations in the groundwater. Alternatively, if the primary source of contaminants is below the water table, a reduction in infiltration could actually increase equilibrium contaminant concentrations in the groundwater.

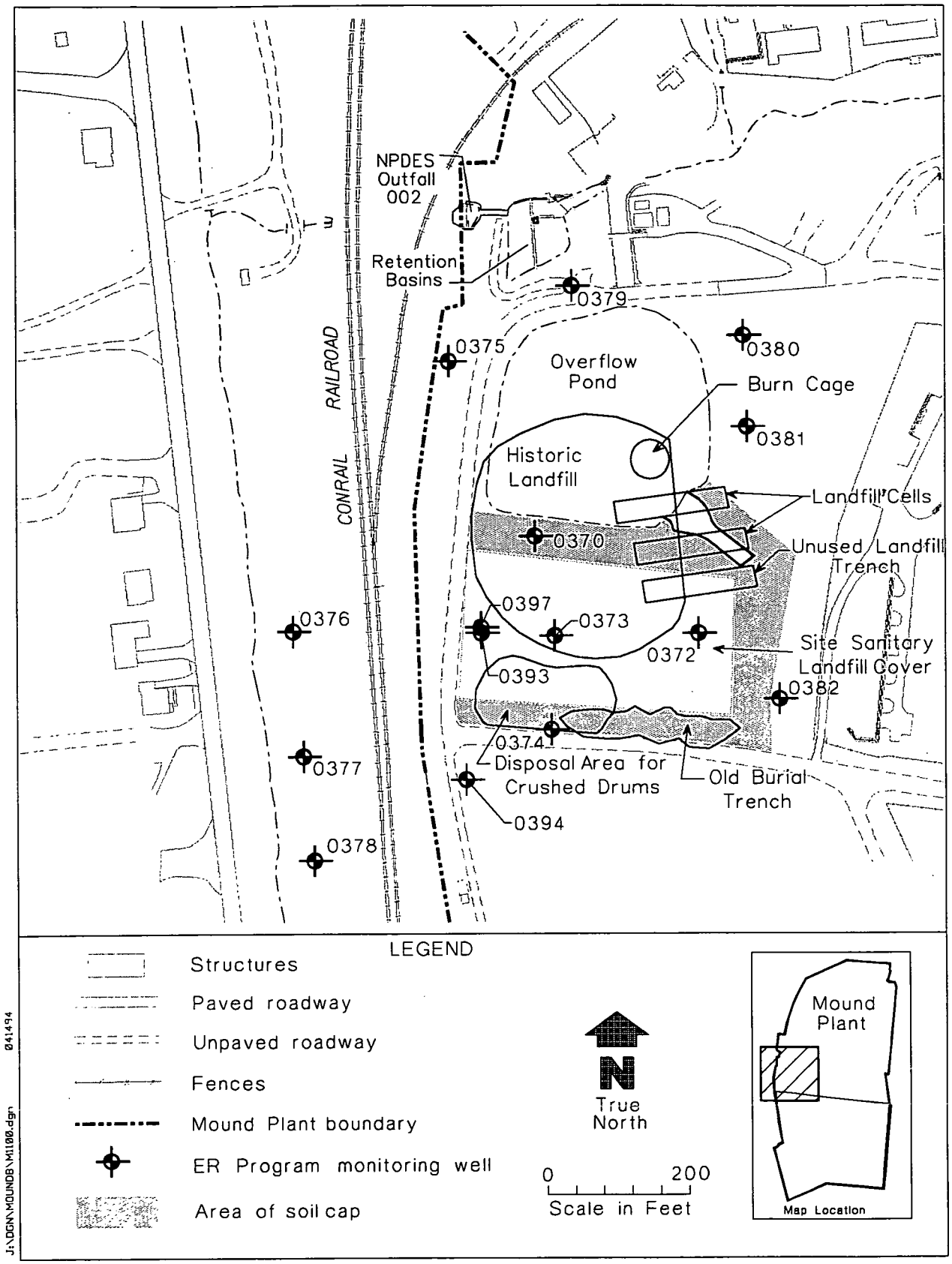


Figure 3.2. Location of augmented Area B surface cap.

Implementability

Implementability of collection and disposal would be the same as described in Alternative 3, and a surface cap would be implementable using conventional construction techniques. However, special design and careful construction would be required for areas with steep slopes.

To make augmentation of the existing cap feasible, the low-permeability soil option was chosen since it was the best match to the existing cap and could be used to extend the cap over the desired areas with less disruption to the current containment system. Given the steep sides of the existing landfill, however, an added degree of difficulty exists in the design and implementation of the surface cap extension.

Cost

Capital costs are estimated to be $560,000. The first-year O&M costs are estimated to be $110,000.

Summary

This alternative would reduce the volume of contamination in the groundwater and its migration downgradient. The addition of the cap would also reduce the mobility of the contaminants in the soils that potentially migrate to the groundwater. This alternative, however, is similar to Alternative 3, and is not materially enhanced by the addition of the cap. This alternative is screened from further consideration.

3.2.5. Alternative 5 - Collection, Treatment, and Disposal

Alternative 5 consists of collection, onsite treatment, and disposal of groundwater from the Mound Plant NPDES-permitted outfall (Table III.1). Groundwater would be extracted as described for Alternatives 3 and 4; and, as with capping, surface controls (such as lining of existing ditches) would be used to limit infiltration.

As groundwater is extracted, it would be treated onsite using a treatment train of process options. The option for treating VOCs in the groundwater will be either air stripping, cascade aeration, or UV/oxidation. OEPA air regulations dictate which groundwater remediation technology is selected; cascade aeration is the most economical way to remove VOCs from the groundwater. In cascade aeration and air stripping, contaminants are transferred from the aqueous phase to the vapor phase and emitted to the atmosphere. When vapor phase treatment is required, the effluent air stream from the

cascade aerator or air stripper is typically run through a carbon adsorption or thermal treatment unit. Both of these technologies are infeasible as offgas treatment because of the groundwater contaminants present at Operable Unit 1. The heavily chlorinated VOCs would produce very corrosive combustion products (hydrochloric acid) in a thermal treatment unit and greatly reduce the expected life of conventional equipment. The low influent concentrations would have a large fuel requirement to achieve efficient destruction. Carbon's affinity to vinyl chloride (one of the groundwater contaminants found at Operable Unit 1) is very low, making efficient removal of vinyl chloride from the vapor effluent cost-prohibitive.

Because neither of these vapor treatments will work for the contaminants found at Operable Unit 1, conventional air stripping or cascade aeration can be used only if uncontrolled emissions from the unit meet OEPA air-quality requirements. Although air modeling may demonstrate that emissions are acceptable, conventional air stripping and cascade aeration will not be considered further. The UV/oxidation process option will be used as the representative process option for onsite groundwater treatment in this and all other applicable alternatives. Power requirements make this technology more expensive per gallon treated, but air emissions are virtually eliminated, and the unit is able to meet air quality requirements.

The existing contaminant concentrations also suggest that cascade aeration can be a viable treatment technology. Such devices are inexpensive to build, and inexpensive and reliable to operate. Provided the expected volatile concentrations are within limits, this would be the technology of choice. The limits on influent concentration are both the amount of volatiles that can be removed by such aerators (removal efficiency) and the amount of volatiles that can be freely released to the atmosphere (air pollution constraints). The utility of cascade aerators will be examined carefully during the detail design phase, should this alternative be selected. However, were it is identified as the candidate technology, the capital and operating costs of the alternative as a whole could be biased low. Should detail design reveal that cascade aerators are unsuitable, the existing cost estimates would be unrealistically low. Therefore, cascade aerators, while remaining a possibly suitable technology, will not be incorporated into the alternatives at this time.

Effectiveness

The effectiveness of groundwater collection would be the same as described in Alternative 3. The aboveground treatment of extracted groundwater would be effective for reducing contaminants to levels low enough to ensure NPDES discharge. Current inorganic levels do not require pretreatment. Monitoring will be performed during the treatment to determine the need for pretreatment; increased inorganic levels could lead to required pretreatment.

Implementability

The components of Alternative 5 are implementable using available construction techniques and water-treatment technologies.

Cost

Capital costs are estimated to be $640,000. The first-year O&M costs are estimated to be $110,000.

Summary

This alternative would reduce the volume of contaminated groundwater and its migration downgradient. Extracted groundwater would be treated before discharge through NPDES-permitted outfall. This alternative is retained for further analysis.

3.2.6. Alternative 6 - Surface Capping, Collection, Treatment, and Disposal

Alternative 6 is similar to Alternative 5 with the addition of a surface cap of low-permeability soil (Table III.1). A surface cap of low-permeability soil would be placed on the ground surface above known waste disposal areas that could be considered potential sources of groundwater contamination. The cap would be designed for integration into the existing cap for the site sanitary landfill and surface drainage structures so that erosion and infiltration would be minimized.

Effectiveness

The effectiveness of the groundwater collection, onsite treatment, and disposal components would remain the same as described for Alternative 5. A surface cap would serve to isolate any remaining soil contamination.

Implementability

The implementability of Alternative 6 would be similar to that described for Alternative 5. The design and installation of a surface cap of low permeability soils utilizes conventional, widely applied construction techniques.

Cost

Capital costs are estimated to be $810,000. The first-year O&M costs are estimated to be $120,000.

Summary

This alternative would reduce the volume of contaminated groundwater and its migration downgradient. The addition of the cap would also reduce the movement of residual contaminants from the soils to the groundwater. This alternative is retained for further consideration.

3.2.7. Alternative 7 - Containment, Collection, and Disposal

Alternative 7 consists of groundwater containment, collection, and disposal (Table III.1). Collection and disposal-without-treatment options would be the same as described in Alternative 3. As groundwater is extracted, it would be discharged through the Mound Plant NPDES-permitted outfall. However, under this alternative, groundwater would also be contained onsite with a low-permeability subsurface wall around the western and southern perimeter of Area B constructed by the slurry column technique (Figure 3.3). Groundwater within Area B would be extracted only at a rate sufficient to maintain a hydraulic gradient across the containment barrier toward Area B (Figure 3.4). If there is any remaining contaminated groundwater south of the Area B containment barrier, a temporary low-discharge extraction well may be installed to enhance dissipation of the contaminants. A converted monitor-well may be used for this purpose. A capture zone formed by this hypothetical well is shown in Figure 3.4.

Effectiveness

The effectiveness of the surface controls and offsite disposal under Alternative 7 will be similar to that described for Alternative 3. A subsurface barrier to groundwater flow may potentially provide more protection for human health and the environment downgradient of the site compared to a recovery-well-induced barrier alone. This difference in protection is because capture zones change in response to pumping variations and groundwater flow directions. Subsurface barrier walls, however, would consistently limit offsite groundwater flow regardless of changing hydrogeological conditions. Three extraction wells pumping at low rates (2 to 5 gpm) in Area B would be effective for maintaining a hydraulic gradient toward Area B because the initial hydraulic gradient would be relatively low after installation of the containment wells (Appendix E).

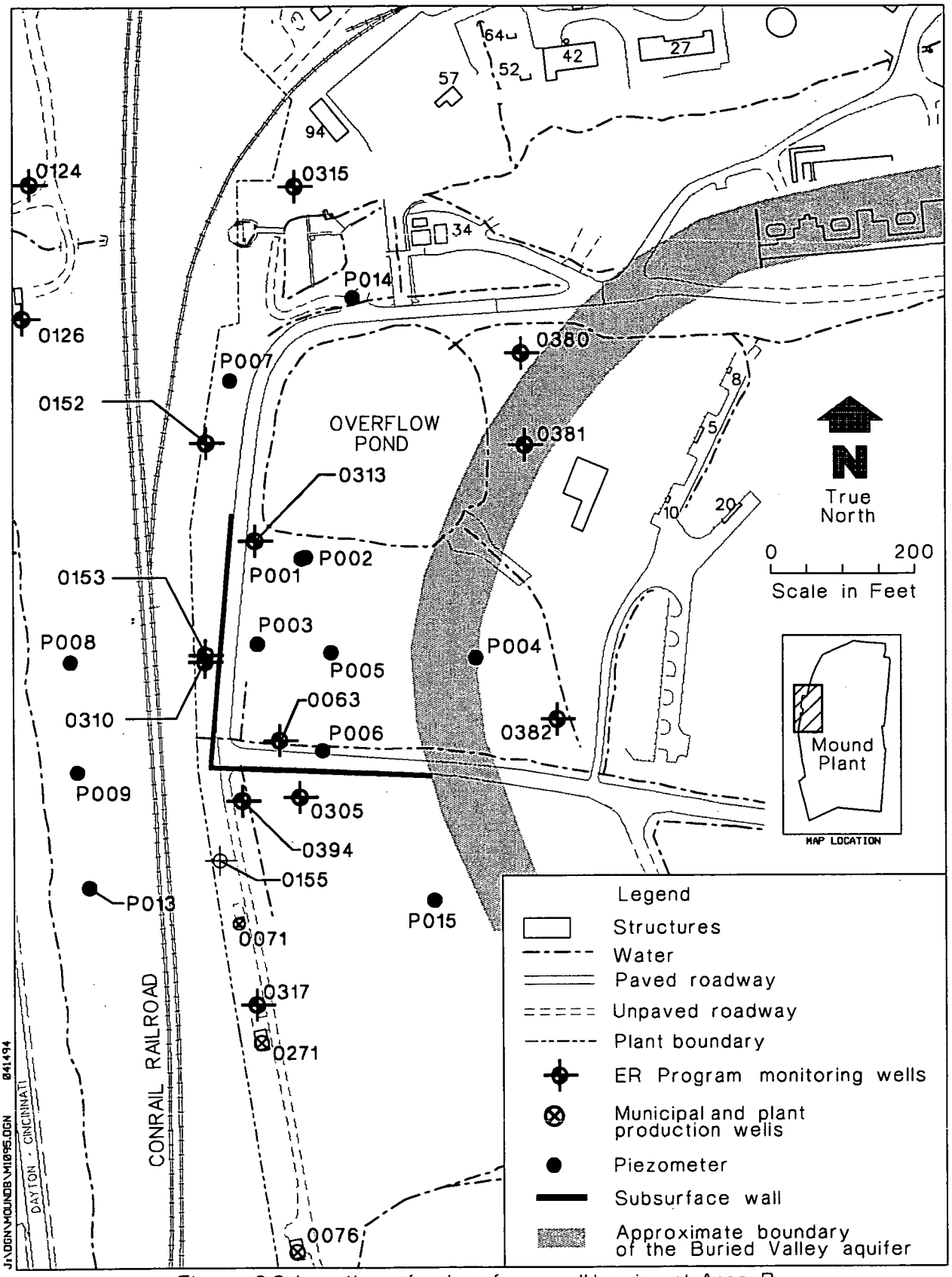


Figure 3.3. Location of subsurface wall barrier at Area B.

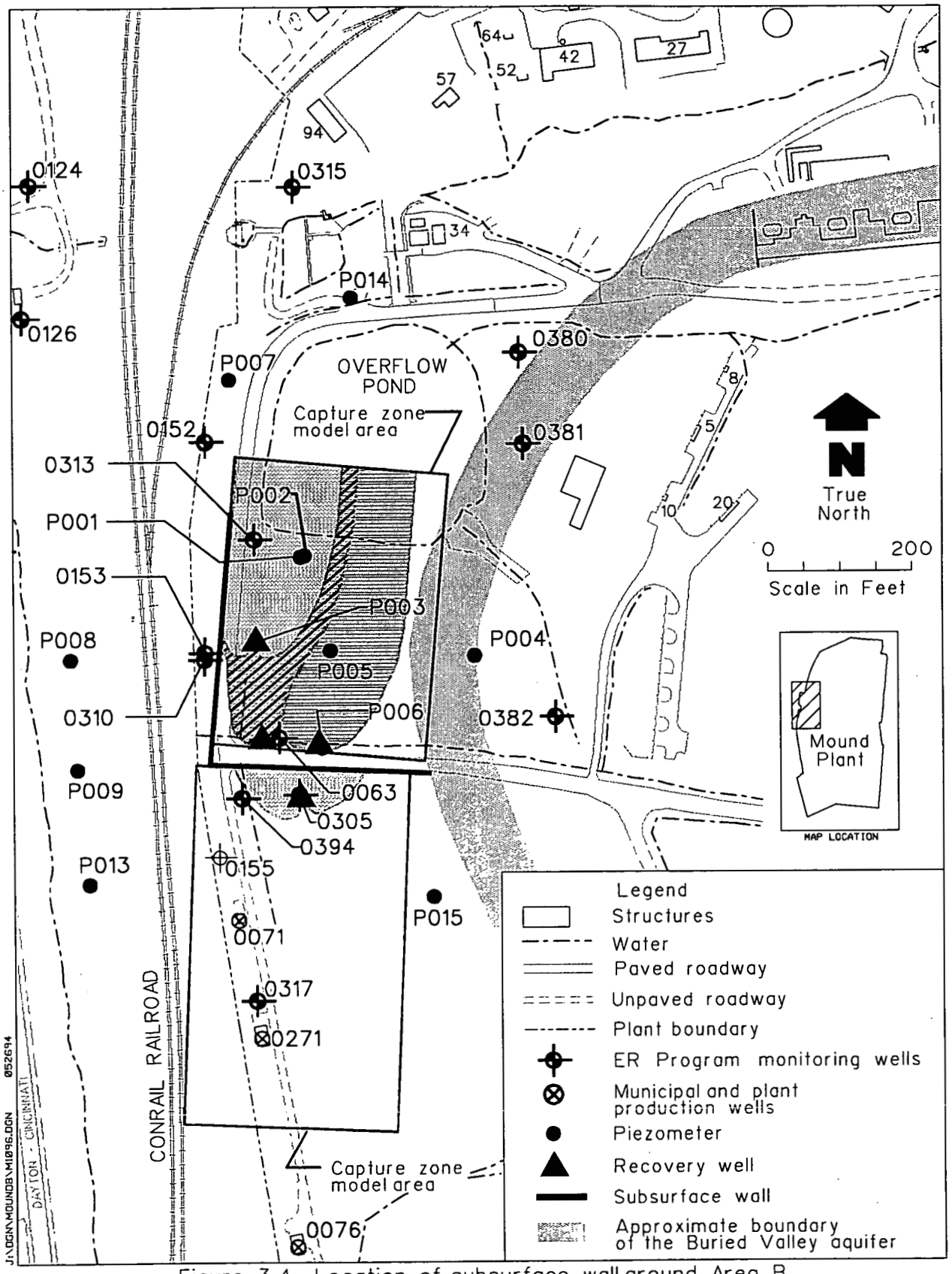


Figure 3.4. Location of subsurface wall around Area B and capture zones created by recovery wells.

The slurry column subsurface barrier is more effective than the slurry wall in protecting the health and safety of workers because little or no contaminated soils are excavated during construction. Bentonite is mixed in place with the natural soil and sediments. Therefore, no materials are produced that would require treatment or offsite disposal.

Implementability

The implementability of groundwater collection and disposal has been described under Alternative 3. The slurry column subsurface barrier has been constructed to depths of up to 50 ft at other sites. Any subsurface utility lines near the proposed location of the subsurface barrier walls would have to be relocated prior to construction.

Cost

Capital costs are estimated to be $850,000. The first-year O&M costs are estimated to be $90,000.

Summary

This alternative would reduce the volume of groundwater contamination. The containment option would also keep contaminated groundwater from potentially migrating offsite. However, the source of groundwater contamination would remain active, which would make the time for contaminated groundwater recovery unpredictable. This alternative is very similar to Alternative 3 and is not enhanced by the addition of the slurry columns. Therefore, this alternative is screened from further consideration.

3.2.8. Alternative 8 - Surface Cap, Containment, Collection, and Disposal

Alternative 8 consists of Area B groundwater containment with a subsurface barrier, recovery of contaminated groundwater from inside and south of Area B, and disposal of the extracted groundwater. A surface cap of low permeability soils has been added to this alternative. The cap would be placed above known waste disposal areas that could be considered potential sources of groundwater contamination. The design of the cap would be integrated with the existing cap for the site sanitary landfill.

Effectiveness

The surface cap would cause a decrease in the rate at which contaminants from the unsaturated zone enter the groundwater. With this source control, groundwater recovery would be more efficient.

Implementability

The implementability of this alternative would be similar to that of Alternative 7. The surface-cap implementability has been described under Alternatives 4 and 6.

Cost

Capital costs are estimated to be $1,000,000. The first-year O&M costs are estimated to be $110,000.

Summary

This alternative would reduce the volume of groundwater contamination. The addition of the cap would also reduce the mobility of the contaminants in the soils that potentially migrate to the groundwater. Contaminated groundwater would be kept from migrating offsite by the containment wall. This alternative is very similar to Alternative 3 and is not enhanced by the addition of a cap. Therefore, this alternative is screened from further consideration.

3.2.9. Alternative 9 - Containment, Collection, Treatment, and Disposal

Alternative 9 consists of groundwater containment with a subsurface barrier, contaminated groundwater recovery from inside and south of Area B, onsite treatment of extracted groundwater, and disposal of the treated groundwater. The subsurface barrier and groundwater collection would be the same as described in Alternatives 7 and 8. The onsite groundwater treatment would be the same as described in Alternatives 5 and 6.

Effectiveness

The effectiveness of the groundwater extraction technologies would be the same as described previously for Alternative 7. The aboveground water treatment technologies may receive groundwater with higher concentrations because the amount of uncontaminated groundwater extracted would be reduced compared to pumping systems not enhanced with containment options. However, because

the treatment train is designed with respect to onsite groundwater concentrations, these increases would not be enough to limit effectiveness.

Implementability

The implementability of Alternative 9 would be the same as described for Alternatives 5 and 7. Combining general response actions would pose no additional implementability problems.

Cost

Capital costs are estimated to be $1,100,000, assuming that no contaminated soil will be excavated because the vertical barrier will be constructed outside of the perimeter of the old landfill. The first-year O&M costs are estimated to be $110,000.

Summary

This alternative would reduce the volume and toxicity of groundwater contamination. Contaminated groundwater would be kept from migrating offsite by a subsurface barrier and groundwater extraction inside the containment. Toxicity of the extracted groundwater would be reduced with the onsite treatment system prior to NPDES-permitted discharge. This alternative is retained for further analysis.

3.2.10. Alternative 10 - Surface Cap, Containment, Collection, Treatment, and Disposal

Alternative 10 consists of a subsurface barrier for groundwater containment, contaminated groundwater recovery within and south of Area B, treatment of the extracted groundwater prior to NPDES-permitted discharge, and a surface cap to reduce infiltration (Table III.1). The subsurface barrier and groundwater recovery components have been described in Alternatives 7 and 8. The treatment technologies have been described in Alternatives 5 and 6. The surface cap has been described in Alternative 4.

Effectiveness

The effectiveness of the subsurface barrier, groundwater recovery, treatment, and disposal components of this alternative would be the same as discussed in previous alternatives. The addition of the surface cap would be effective at isolating any residual unsaturated zone contaminants from the groundwater medium, which may reduce the length of time of groundwater recovery.

Implementability

The components in this alternative are implementable with conventional construction techniques. Their implementability has been described in previous alternatives.

Cost

Capital costs are estimated to be $1,300,000, assuming that no contaminated soil will be excavated because the vertical barrier will be constructed outside of the perimeter of the old landfill. The first-year O&M costs are estimated to be $120,000.

Summary

The subsurface barrier and groundwater recovery components of this alternative would reduce groundwater contaminant volume and mobility. The onsite treatment technologies would reduce contaminant toxicity prior to discharge. The surface cap would reduce groundwater contamination sources. This alternative is retained for further analysis.

3.2.11. Alternative 11 - *In Situ* Groundwater Treatment

Alternative 11 consists of subsurface permeable treatment walls and slurry columns (Table III.1). Subsurface permeable treatment walls are composed of a mixture of iron shavings and sand installed in the subsurface downgradient of the site. The slurry columns serve to direct the flow of groundwater toward the treatment walls and minimize movement of groundwater offsite (Figure 3.5).

Effectiveness

Reports of bench-scale and field pilot-scale studies have shown effective chlorinated-VOC removal by permeable treatment walls composed of iron filings mixed with sand (Gillham et al. 1993). No inorganic or biological precipitates were found when one of the treatment walls from a pilot study was cored after two years of operation (Vogan 1994). Uncertainties arise with respect to long-term performance given the site-specific inorganic groundwater chemistry and the feasibility of directing groundwater flow into the permeable treatment wall with seasonal variations in groundwater flow direction. Bench-scale and pilot-scale treatability studies would be necessary to reduce the uncertainty associated with the long-term effectiveness of the treatment wall with respect to the site geochemistry. Detailed, numerical, flow modeling would reduce the uncertainty associated with subsurface barrier effects on groundwater flow.

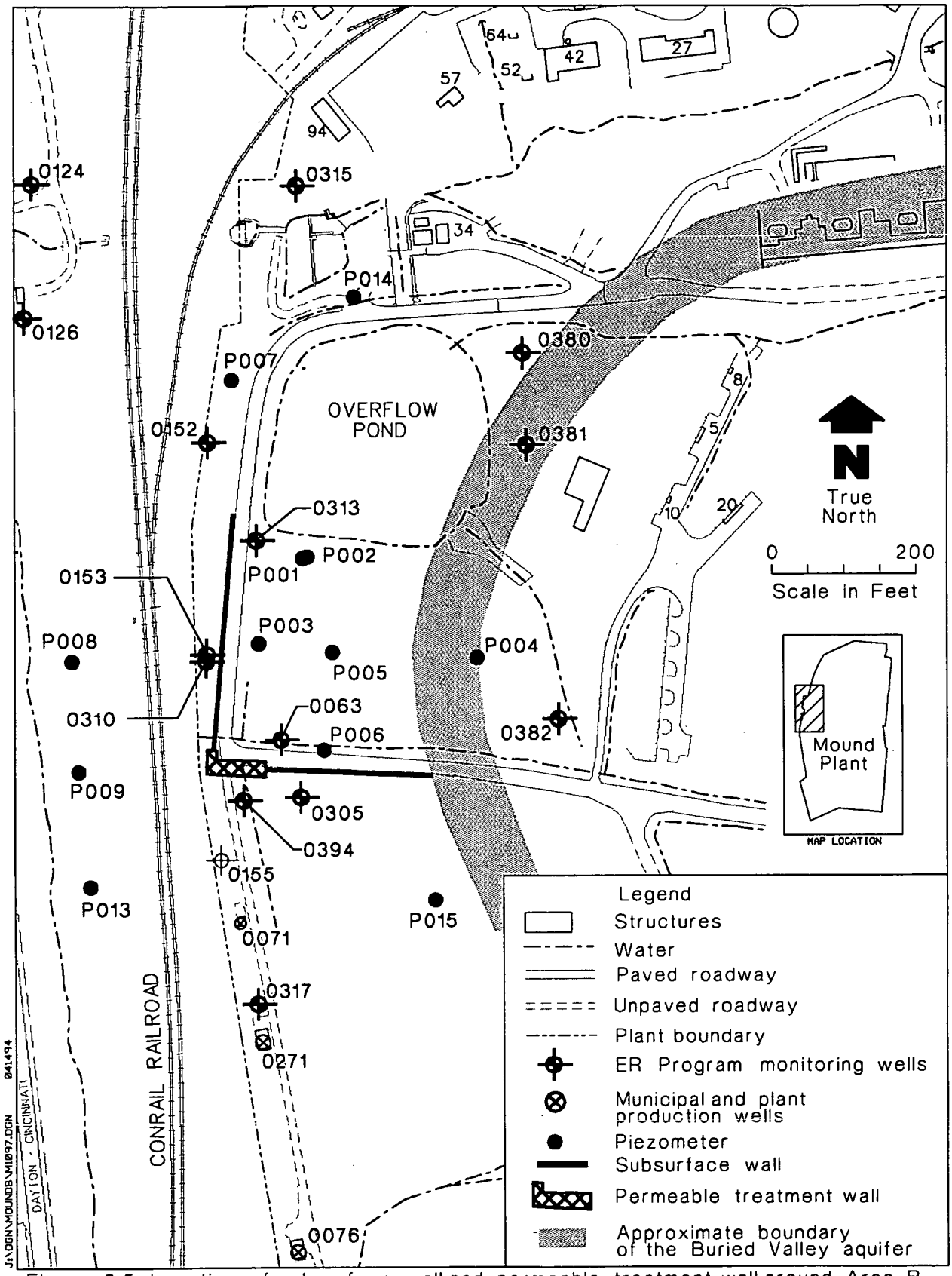


Figure 3.5. Location of subsurface wall and permeable treatment wall around Area B.

Implementability

If needed to ensure that the groundwater flow direction is toward the outside of Area B through the treatment wall, a recovery well could be located south of the containment area. The well is not a major component of the system and could be added later if warranted. This recovery well would be pumped at a rate that would maintain a lower groundwater level outside the treatment wall ensuring outward groundwater flow. The capture zone created by this well would also intercept any remaining groundwater contamination just south of Area B outside of the containment. Because this extraction well would withdraw much more noncontaminated groundwater than contaminated groundwater, it would be expected that because of dilution, this untreated water could be discharged through the NPDES-permitted outfall.

The implementability of the slurry column has been described under Alternative 7. Conventional techniques are used in construction of the permeable treatment wall.

Cost

Capital costs are estimated to be $1,300,000, assuming that no contaminated soil will be excavated because the vertical barrier will be constructed outside of the perimeter of the old landfill. The first-year O&M costs are estimated to be $76,000.

Summary

Because this alternative uses a passive system to treat contaminated groundwater, O&M costs, such as power usage and disposal, are not required. Also, implementing this alternative effectively reduces the contaminant mass in the groundwater *in situ*. However, as with other alternatives not augmented with the capping option, the source for groundwater contamination remains active, which would make the time for contaminated groundwater recovery unpredictable. This alternative is retained for further investigation.

3.2.12. Alternative 12 - Surface Cap and *In Situ* Groundwater Treatment

Alternative 12 is similar to Alternative 11 with the addition of a surface cap (Table III.1). The design of the surface cap has been described in previous alternatives.

Effectiveness

The effectiveness of Alternative 12 would increase relative to that of Alternative 11. A surface cap would decrease the migration of contaminants from the source, which would mean less groundwater contamination to remediate over the long term. However, if the treatment wall remains an effective treatment technology in the long term (i.e., over 20 years), control of the source may not be critical. If that is the case, uninhibited leaching of unsaturated zone contamination may be desirable as a long-term remediation measure.

Implementability

Construction of the surface cap and in-situ groundwater treatment would use conventional techniques as described in previous alternatives. The permeable treatment wall, however, is an innovative technology that requires special installation techniques.

Cost

Capital costs are estimated to be $1,400,000, assuming that no contaminated soil will be excavated because the vertical barrier will be constructed outside of the perimeter of the old landfill. The first-year O&M costs are estimated to be $92,000.

Summary

As with Alternative 11, this alternative effectively reduces the contaminant mass in the groundwater *in situ*. The addition of the cap would also reduce the mobility of the contaminants in the soils that potentially migrate to the groundwater. This alternative is retained for further analysis.

3.3. SELECTION OF ALTERNATIVES FOR DETAILED ANALYSIS

Table III.2 lists the alternatives retained for the detailed analysis described in Section 4. Table III.3 describes how these retained alternatives are renumbered for use in Section 4.

Table III.2. Alternatives Array for the Detailed Analysis

General Response Action			1	2	3	5	6	9	10	11	12
Medium	Technology Type	Area or Volume	No Action	Instit-utional	Collect Disposal	Collect Treat Disposal	Surface Cap Collect Treat Disposal	Contain Collect Treat Disposal	Surface cap Contain Collect Treat Disposal	*In Situ* Ground-water Treatment	Surface Cap + *In situ* Ground-water Treatment
Soil and Ground-water	Monitoring	entire site		●	●	●	●	●	●	●	●
	Access Restriction	entire site		●	●	●	●	●	●	●	●
Soil	Surface Controls	entire site			●	●	●	●	●	●	●
	Surface Capping	part of site					●		●		●
Ground-water	Subsurface Barriers	entire site						●	●		
	Extraction	entire site			●	●	●	●	●		
	Above- ground Treatment[a]	all water				●	●	●	●		
	In situ Treatment[b]	all water								●	●
	Disposal	all water			●	●	●	●	●		

[a] Aboveground groundwater treatment options, and ultraviolet/oxidation.
[b] *In situ* groundwater treatment option is the permeable treatment wall.

Table III.3. Renumbering of Alternatives

Short Title	Old Number in Section 3	New Number in Section 4
No Action	1	1
Institutional	2	2
Collect, Disposal	3	3
Collect, Treat, Disposal	5	4
Surface Cap, Collect, Treat, Disposal	6	5
Contain, Collect, Treat, Disposal	9	6
Surface Cap, Contain, Collect, Treat, Disposal	10	7
In-situ Groundwater Treatment	11	8
Surface Cap, *In-situ* Groundwater Treatment	12	9

4. DETAILED ANALYSIS OF ALTERNATIVES

This section presents a detailed analysis of the alternatives that were retained from the initial screening, which is presented in Section 3. Detailed estimates of capital costs and O&M costs are presented in Appendix F. The remaining alternatives have been summarized and renumbered sequentially as shown in Table IV.1. Each alternative is evaluated in detail using nine evaluation criteria, which are categorized into three criteria groups:

- threshold criteria
  - overall protection of human health and the environment, and
  - compliance with ARARs (unless a specific ARAR is waived)
- primary balancing criteria
  - long-term effectiveness and permanence,
  - reduction of toxicity, mobility, and/or volume through treatment,
  - short-term effectiveness,
  - implementability, and
  - cost
- modifying criteria
  - state acceptance, and
  - community acceptance.

The modifying criteria are not used to analyze the alternatives in this section. State acceptance of any of the alternatives has been determined by draft-document review by the OEPA. After the FS report is finalized and the proposed plan is released, a public comment period will follow. The nature of the public comments will determine the public acceptance of any alternative.

4.1. ALTERNATIVE 1 - NO ACTION

Under Alternative 1, no action would be taken at Operable Unit 1. The only evaluation criteria applicable to this alternative are the threshold criteria: compliance with ARARs and overall protection of human health and the environment. Analysis of the alternative based on these criteria is discussed in the following sections.

4.1.1. Compliance with ARARs

The no-action alternative would not comply with ARARs. Also, it would not meet risk-based criteria.

Table IV.1. Detailed Analysis of Alternatives

Alternative number	Compliance with ARARs	Short-term effectiveness	Long-term effectiveness and permanence	Overall protection of human health and environment	Reduction of toxicity, mobility, or volume of contaminants	Implementability	Cost
1-No action	Will not meet chemical-specific ARARs. No action or location-specific ARARs apply. Does not meet risk-based criteria.	Not applicable.	Not applicable.	See RI risk assessment	Not applicable	Not applicable	Not applicable
2-Institutional control	No compliance with ARARs. Does not meet risk-based criteria.	Minimal worker and community risks during the installation of a fence easily mitigated. No significant environmental impacts. Remedial action objectives are not met.	Risk associated with the source term and groundwater would remain. Eventual reduction of risk from natural degradation and dispersion of VOCs and tritium.	Access restrictions may not be completely enforceable, especially if the plume has the potential to migrate to offsite areas.	Volume of contaminated groundwater is increased. Mobility of plume will increase as it reaches areas of higher groundwater velocity. Toxicity will be reduced as natural degradation occurs.	Implementable onsite. Offsite implementability not probable.	$3,980,000
3-Collect/ disposal	Will meet chemical- and action-specific ARARs as long as the remedial action is operational. No location-specific ARARs apply. Will meet risk-based criteria. Will comply with chronic freshwater criteria ARAR.	Minimal worker and community risks during construction are easily mitigated. No significant environmental impact.	Risk associated with the source term would remain. Uncertainties associated with the source term and contaminant absorption make any predictions of the remedial action lifetime indeterminate.	As long as the remedial action is implemented, potential for human and environmental exposure is limited.	Toxicity, mobility, and volume of the groundwater contaminants will be reduced while the remedial action is operational. This remedial option will not reduce the mobility of the soil contaminants.	Easily implementable.	$262,000[a]
4-Collect/treat/ disposal	Will meet chemical- and action-specific ARARs as long as the remedial action is operational. No location-specific ARARs apply. Will meet risk-based criteria.	Minimal worker and community risks during construction are easily mitigated. No significant environmental impact.	Risk associated with the source term would remain. Uncertainties associated with the source term and contaminant absorption make any predictions of the remedial action lifetime indeterminate.	As long as the remedial action is implemented, potential for human and environmental exposure is limited.	Toxicity, mobility, and volume of the groundwater contaminants will be reduced while the remedial action is operational. This remedial option will not reduce the mobility of the soil contaminants.	Easily implementable.	$1,740,000[a]

Table IV.1. (page 2 of 3)

Alternative number	Compliance with ARARs	Short-term effectiveness	Long-term effectiveness and permanence	Overall protection of human health and environment	Reduction of toxicity, mobility, or volume of contaminants	Implementability	Cost
5-Surface cap/ collect/treat/ disposal	Will meet chemical- and action-specific ARARs as long as the remedial action is operational. No location-specific ARARs apply. Will meet risk-based criteria.	Minimal worker and community risks during construction are easily mitigated. No significant environmental impact.	Risk associated with the source term would remain but be reduced by the presence of the cap. Uncertainties associated with the source term and contaminant absorption make any predictions of the remedial lifetime indeterminate. The presence of the cap would reduce the contaminant flux into groundwater which may reduce the remedial action lifetime.	As long as the remedial action is implemented, potential for human and environmental exposure is limited. The cap may accelerate remediation time by reducing contaminant flux into groundwater, reduce potential soil exposure.	Toxicity, mobility, and volume of the groundwater contaminants will be reduced while the remedial action is operational. This remedial option will reduce the mobility of the soil contaminants.	Easily implementable.	$2,390,000[a]
6-Contain/ collect/treat/ disposal	Will meet chemical- and action-specific ARARs as long as the remedial action is operational. No location-specific ARARs apply. Will meet risk-based criteria.	Worker and community risks during slurry column installation would have to be minimized. Disposal may be required for residual soils generated from the slurry column installation.	Risk associated with the source term would remain. Uncertainties associated with the source term and contaminant absorption make any predictions of the remedial action lifetime indeterminate. However, the containment will reduce the remedial action lifetime.	As long as the remedial action is operational, potential for human and environmental exposure is limited. The containment may accelerate remediation.	Toxicity, mobility, and volume of the groundwater contaminants will be reduced while the remedial action is operational. This remedial option will not reduce the mobility of the soil contaminants. The slurry wall will reduce the offsite migration of groundwater contaminants during brief shutdown periods.	Easily implementable after the completion of preconstruction surveys for the slurry columns.	$2,650,000[a]
7-Surface cap/ contain/ collect/treat/ disposal	Will meet chemical- and action-specific ARARs as long as the remedial action is operational. No location-specific ARARs apply. Will meet risk-based criteria.	Worker and community risks during slurry column installation would have to be minimized. Disposal may be required for residual soils generated from the slurry column installation.	Risk associated with the source term would remain but be reduced by the presence of the cap. Uncertainties associated with the source term and contaminant absorption make any prediction of the remedial action lifetime indeterminate. The presence of the cap and containment would significantly reduce the remedial action lifetime.	As long as the remedial action is operational, potential for human and environmental exposure is limited. The cap and containment may accelerate remediation and reduce potential soil exposure.	Toxicity, mobility, and volume of the groundwater contaminants will be reduced while the remedial action is operational. This remedial option will reduce the mobility of the soil contaminants. The slurry wall will reduce offsite migration of groundwater contaminants during brief shutdown periods.	Easily implementable after the completion of preconstruction surveys for the slurry columns.	$3,300,000[a]

Table IV.1. (page 3 of 3)

Alternative number	Compliance with ARARs	Short-term effectiveness	Long-term effectiveness and permanence	Overall protection of human health and environment	Reduction of toxicity, mobility, or volume of contaminants	Implementability	Cost
8-*In situ* groundwater treatment	Will meet chemical- and action-specific ARARs as long as permeable barrier is functional. No location-specific ARARs apply. Will meet risk-based criteria.	Exposure risk to workers will increase during excavation activities. Worker and community exposure during construction/installation phases would have to be minimized. Disposal would be required for any contaminated residual soils generated from the slurry wall installation. The remedial action would take longer than a pump and treat technology to reach remediation goals.	Risk associated with the source term would remain. Uncertainties associated with the source term and contaminant absorption make any prediction of the remedial action lifetime indeterminate. This passive alternative offers more permanence than the active alternatives.	Potential for human and environmental exposure is greatly reduced over pump and treat technologies.	Toxicity, and mobility of the groundwater contaminants will be reduced. This remedial option will not reduce the mobility of the soil contaminants.	This technology has not been implemented on a full scale, but has been effective in pilot scale studies. Agency approval may be difficult to obtain due to lack of previous full-scale remedial actions with this technology.	$1,980,000[a]
9-Surface cap/*in situ* groundwater treatment	Will meet chemical- and action-specific ARARs as long as permeable barrier is functional. No location-specific ARARs apply. Will meet risk-based criteria.	Exposure risk to workers will increase during excavation activities. Worker and community exposure during construction/ installation phases would have to be minimized. The remedial action would take longer than a pump and treat technology to reach remediation goals.	Risk associated with the source term would remain but be reduced by the presence of the cap. Uncertainties associated with the source term and contaminant absorption make any prediction of the remedial action lifetime indeterminate. This passive alternative offers more permanence than the active alternatives.	Potential for human and environmental exposure is greatly reduced over pump and treat technologies. Risks from potential soil exposure are minimized.	Toxicity, and mobility of the groundwater contaminants will be reduced. This remedial option will reduce the mobility of the soil contaminants.	This technology has not been implemented on a full scale, but has been effective in pilot scale studies. Agency approval may be difficult obtain due to lack of previous full-scale remedial actions with this technology.	$2,630,000[a]

[a]This total cost is in addition to the total cost shown under Alternative 2 (common cost).

4.1.2. Overall Protection of Human Health and the Environment

For the no-action alternative, the risks associated with unrestricted access to contaminated groundwater result primarily from VOC contamination. The lifetime excess cancer-risk for a residential scenario is estimated at 5×10^{-4} and the hazard index for noncarcinogens is 36. The lifetime excess cancer-risk from exposure to contaminated soil for an industrial scenario is estimated at 6×10^{-6}. The potential environmental impacts of no action at the site will be evaluated in the Site ecological assessment.

As with any baseline risk assessment, considerable uncertainties are associated with these estimates. For the no-action alternative, the most significant uncertainty is whether maximum contaminant concentrations have been detected by previous site investigations. If access to the landfill and underlying groundwater were not restricted and areas were excavated for future land use, it is likely that significantly higher levels of contamination would be encountered than those evaluated in the baseline risk assessment. Some hot spots or buried materials could present an imminent risk to human health or the environment if they were encountered and released.

4.2. ALTERNATIVE 2 - INSTITUTIONAL CONTROLS

As opposed to the no-action alternative, this alternative includes the installation of a fence to prevent access to the landfill and may also include mechanisms, such as deed restrictions, to restrict access to groundwater.

4.2.1. Compliance with ARARs

This alternative does not comply with ARARs throughout the site.

4.2.2. Short-Term Effectiveness

An environmental impact is not likely to be associated with this action. Because the contamination is not addressed, this alternative does not meet remedial action objectives.

4.2.3. Long-Term Effectiveness and Permanence

Risks associated with the source and groundwater would remain the same as under the no-action alternative. It is likely that organic contaminants would eventually degrade biologically. However,

contaminant concentrations could increase if contaminants were released from suspected source areas in the future.

4.2.4. Overall Protection of Human Health and the Environment

Institutional controls would restrict access to the landfill and contaminated groundwater, thereby reducing or eliminating potential onsite human exposures. However, access restrictions may not be enforceable at offsite areas where the plume may migrate. Based on current data, offsite concentrations do not pose a significant risk, although these concentrations could become significant if production wells were shut down or if additional contaminants were released from suspected Area B source-areas. Alternatively, if production wells were not shut down, the contaminant levels in these wells could pose a significant risk as the plume is pulled toward them. Environmental impacts would be similar to those associated with no action. Again, considerable uncertainties are associated with these estimates.

4.2.5. Reduction of Toxicity, Mobility, or Volume of Contaminants

The volume of contaminated groundwater would increase as the plume spread, although the concentrations would likely decrease as the contaminants disperse through a larger area. The mobility of the plume would increase if it reached areas of higher groundwater velocity in the Buried Valley aquifer. Generally, toxicity will be reduced as contaminants are broken down. However, in the case of TCE and DCE, both degrade to the more toxic metabolite, vinyl chloride.

4.2.6. Implementability

Institutional controls could be easily implemented onsite using conventional construction practices. This alternative could also be easily implemented from an administrative standpoint because, for the foreseeable future, DOE will retain control over land use within the Mound Plant. However, enforcing deed restrictions and controlling use of groundwater offsite could be very difficult.

4.2.7. Cost

The following costs represent costs of elements common to all alternatives. The capital cost for Alternative 2 is $139,000. The annual O&M cost is $201,000, and the present value of the 30-year O&M cost is $3,840,000. The total cost is $3,980,000. Common costs would be in addition to the capital cost, O&M, present-value O&M, and total costs given for each alternative.

4.3. ALTERNATIVE 3 - COLLECTION AND DISPOSAL

Alternative 3 consists of groundwater collection and NPDES-permitted disposal of the extracted groundwater. Groundwater would be extracted from two wells pumping a total of 45 gpm (Figure 3.1) and piped to the NPDES-permitted outfall where it would be discharged to the Great Miami River.

4.3.1. Compliance with ARARs

The VOC concentrations in the discharge water from this remediation system would comply with the Chronic Freshwater Criteria ARARs according to the following assumptions:

- Two wells with equal capacities and discharge rates, which are assumed to be about 25 gpm each,
- Well 1, draining water from near monitor well 370, will have VOC concentrations similar to those in 370, according to data from 1993 and 1994.
- Well 2, near monitor well 63, will have VOC concentrations similar to those in 63, according to data from December 1991 through 1994.
- The combined discharge would have concentrations near the arithmetic average of the two wells.

Table IV.2 shows the anticipated initial concentrations from each well, their average, and the Chronic Freshwater Criteria for each contaminant. The initial concentrations could increase somewhat during the early stages of remediation but should begin to fall exponentially within a few months. The VOCs shown are those identified as COCs (human health) from the risk assessment plus other VOCs with noticeable concentrations in the monitor wells. The initial concentrations are less than the Freshwater Criteria.

Also shown on Table IV.2 are anticipated dissolved metals concentrations in the discharge. These data are from the filtered samples collected during the Operable Unit 9 groundwater sweeps. As may be seen, with the exception of metals whose detection limits are near or above the chronic Freshwater Criteria, only zinc is of possible concern. Background values of zinc have not been established for the Great Miami River, and the discharge of zinc in Mound Plant NPDES outfall 0001 is monitored, but not limited.

4.3.2. Short-Term Effectiveness

The community and workers could be exposed to airborne COCs caused by volatilization of groundwater contaminants during pipeline construction or installation of the extraction wells. To

Table IV.2. Observed Concentrations (in μg/L) and Computations of Estimated Discharges for Alternative 3

Volatile Organic Compound	Well 63	Well 370	Average	Chronic Freshwater Criteria[b]
1,2-*cis*-dichloroethene (DCE)	13.	535.	274.	11,600.[a] [total DCE]
1,2-*trans*-DCE	4.7	1.8	3.2	-
tetrachloroethene (PCE)	23.	228.	125.	840.
tetrachlomethane (carbon tetrachloride)	2.9	3.9	3.4	35,200.[a]
1,1,1-trichloroethane (1,1,1-TCA)	0.4	1.0	0.7	18,000. [all chlorinated ethanes]
trichloroethene (TCE)	23.	149.	86.	21,900.
trichlorofluoromethane	3.6	7.1	5.4	-
trichloromethane (chloroform)	6.	80.	43.	1,240.
chloroethene (vinyl chloride)	3.9 [well 374]	3.2	3.6	-
Anticipated Metals Concentration for Remedy				
Dissolved Metal				
Cd	0.98 U	0.62 U	0.80 U	1.1
Cr	1.12 U	0.75 U	0.94 U	11
Cu	1.9	0.90 U	1.40	12
Fe	295	387	341	1,000
Pb	2.0 U	2.25 U	2.1	3.2
Hg	0.10 U	0.10 U	0.10 U	0.012
Ni	2.5 U	113	58	96
Ag	1.28 U	0.75 U	1.02 U	0.12
Zn	357	5.0	181	47

[a]acute criterion; no chronic criteria listed.
[b]1988 Water Quality Criteria
- no criterion.
U = not detected at the limit shown

mitigate the possibility of any exposure, continuous air-monitoring would be performed during all construction/installation work, and, if necessary, appropriate mitigation measures would be employed. No significant environmental impacts would be expected as a result of this remedial action.

4.3.3. Long-Term Effectiveness and Permanence

Under this alternative, long-term monitoring of groundwater flow and extraction-well efficiency, as well as adequate maintenance and adjustments through time, would ensure long-term effectiveness of the groundwater recovery system.

Simplified calculations using the estimated groundwater velocity under groundwater recovery conditions and the highest COC retardation coefficient (TCE) indicate that groundwater would move through Area B as much as 30 times faster than the VOC contaminants (Appendix E). This suggests that many pore volumes of groundwater would have to be removed from beneath Area B to achieve PRGs.

Soil contamination would be reduced over time by leaching contaminants into the groundwater. Prediction of the lifetime of remedial action is indeterminate without additional characterization of the source, unsaturated zone, and geochemistry because of the uncertainties of estimating contaminant flux through the unsaturated zone and contaminant adsorption/desorption on the aquifer matrix.

4.3.4. Overall Protection of Human Health and Environment

Extracting groundwater would significantly reduce the potential for offsite contaminant migration. However, if the system is shut down for an extended time, offsite groundwater flow could occur; temporary shutdowns for maintenance purposes would not have adverse effects. Maintaining the contaminated groundwater within the boundaries of Area B significantly reduces the potential for adverse effects to human health and the environment. However, the mobility of soil contaminants through the unsaturated zone would not be reduced with this alternative.

Assuming all discharges are in compliance with an NPDES permit, environmental impacts associated with this remedial action could likely be comparable to the no-action alternative. However, it is possible that the recovery wells could pump unanticipated contaminants (e.g., metals at concentrations that could pose a risk to surface water receptors). Such contamination could be mitigated by adequate monitoring and short-term treatment as described in the next alternative.

4.3.5. Reduction of Toxicity, Mobility, and Volume

Extracting contaminated groundwater would reduce mobility and volume of contaminants in the groundwater.

In areas where infiltration is not controlled, the contaminants found in the unsaturated zone would be reduced over time through leaching into the groundwater and from natural degradation processes; their mobility would not be reduced with this technology. The contaminants in the soil would continue to act as a source even after the removal of several pore volumes of groundwater. However, the recovery wells would create a hydraulic barrier that would prohibit most groundwater from moving offsite.

4.3.6. Implementability

This remedial alternative

- uses standard construction techniques,
- has been proven to run with minimal operating problems at other sites,
- uses standard equipment that can be obtained from multiple vendors, and
- can be operated by site personnel after an orientation by the selected vendor.

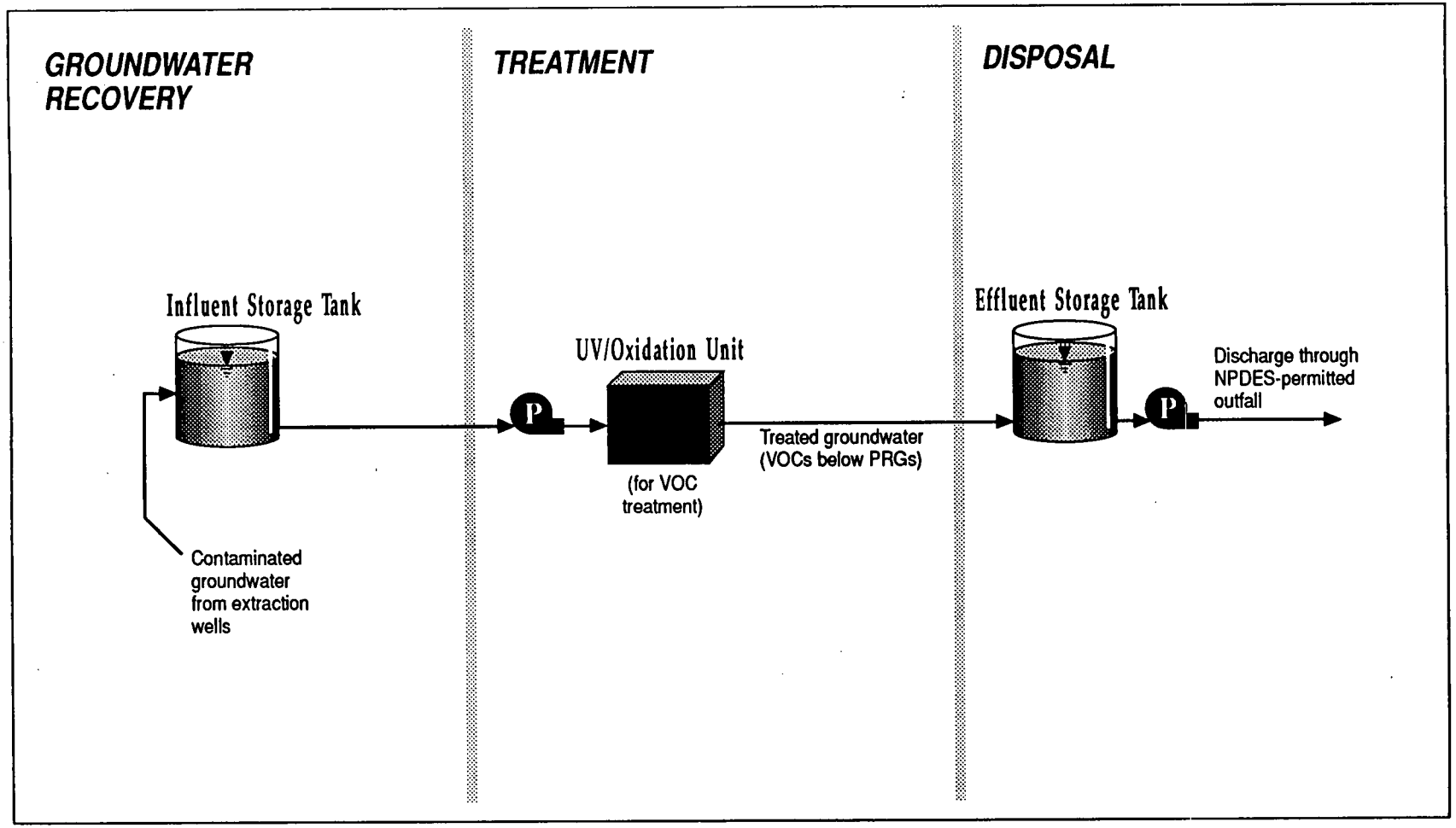
Disposal would consist of an NPDES-permitted discharge to the Great Miami River. The discharge volumes (approximately 45 gpm) would be a small increment in the current NPDES discharge.

4.3.7. Cost

The capital cost for Alternative 3 is $205,000. The annual O&M cost is $3,000, and the 30-year O&M cost is $57,300. The total cost is $262,000 (plus the common costs from Alternative 2).

4.4. ALTERNATIVE 4 - COLLECTION, TREATMENT, AND DISPOSAL

Alternative 4 consists of onsite collection and treatment and NPDES-permitted disposal of groundwater. Groundwater would be extracted from two wells, pumping a total of 45 gpm (Figure 3.1), and pumped to an influent storage tank to allow system stabilization and influent sampling representative of the average concentrations entering the treatment equipment. Groundwater with added hydrogen peroxide would then be pumped from the influent storage tank to an UV/oxidation unit where the VOCs would be destroyed (Figure 4.1). In the UV/oxidation unit, a low-pressure UV lamp assembly would irradiate



MND/OU1/FS-01/4-18-94

LEGEND:
P = pump
VOCs = volatile organic compounds
UV = ultra violet

Figure 4.1. Flow diagram for groundwater treatment with UV/oxidation unit.

the groundwater as it passed through; the UV radiation would produce hydroxyl radicals from the added hydrogen peroxide. The organic contaminants would then be oxidized by the hydroxyl radicals, causing their decomposition into carbon dioxide, water, halides, and, in some cases, organic acids (EPA 1993b). The treated groundwater would then be pumped to the effluent storage tank to allow for effluent sampling prior to an NPDES-permitted discharge to the Great Miami River.

As discussed in Section 3, the UV oxidation treatment system is one of several potentially viable treatment trains for VOCs. Both cascade aeration and conventional air stripping offer the possibility of adequate treatment. Since only one representative technology is needed to support thorough discussion of an alternative, only UV oxidation is presented. Final selection of technologies will be done during remedial design, when any of these systems may be determined to be optimal.

4.4.1. Compliance with ARARs

The UV/oxidation unit would be designed so that ARARs are met. All discharges would be monitored to ensure that discharges are meeting the requirements set by the NPDES permit, which must be obtained prior to startup of the remedial action. The remedial action would be operated until the COC groundwater concentrations are at or below risk-based PRGs.

4.4.2. Short-Term Effectiveness

The community and workers could be exposed to airborne COCs, caused by the volatilization of groundwater, during the construction or installation of the remedial equipment and operation of the treatment equipment. To mitigate the possibility of any exposure, the following procedures would be implemented:

- Continuous air monitoring would be performed during all construction/installation work, and if necessary, appropriate mitigation measures would be employed.
- All equipment in the treatment process would be sealed to prevent volatilization of contaminants.

No significant environmental impacts are expected as a result of this remedial action.

4.4.3. Long-Term Effectiveness and Permanence

UV/oxidation has been proven effective for the destruction of VOCs in extracted water at many sites. The destruction efficiencies required to meet typical NPDES-permit discharge limits is attainable. The

collection, treatment, and disposal system would be designed so that the monitoring required to determine influent and effluent concentrations would be easily accomplished.

The UV/oxidation system requires regular maintenance by trained personnel, including cleaning the low-pressure UV lamp assembly and replacing components when needed. Cleaning frequency ranges from once per month to once every three months depending on concentration of suspended solids formed during treatment or in the influent (EPA 1993b). The low-pressure UV lamps require replacement every 3,000 hours to maintain maximum efficiency of operation (EPA 1993b). Other components of the system such as valves, gaskets, pipings, the hydrogen peroxide feed module, and pumps should be checked for leaks and proper operation once per month (EPA 1993b).

Because no toxic residuals would be produced, the future liabilities associated with offsite disposal do not need to be considered.

Simplified calculations using the estimated groundwater velocity under groundwater recovery conditions and the highest COC retardation coefficient (TCE) indicate that groundwater would move through Area B as much as 30 times faster than the VOC contaminants (Appendix E). This movement suggests that many pore volumes of groundwater would have to be removed from beneath Area B to achieve PRGs.

Soil contamination would be reduced over time by leaching of contaminants into the groundwater. Due to the uncertainties of estimating contaminant flux through the unsaturated zone and contaminant adsorption/desorption on the aquifer matrix, prediction of the lifetime of remedial action is indeterminate without additional characterization of the source, unsaturated zone, and geochemistry.

4.4.4. Overall Protection of Human Health and Environment

Groundwater extraction significantly reduces the potential for offsite contaminant migration. If the extraction system is shut down for an extended time, offsite groundwater flow could occur; temporary shutdowns for maintenance purposes would not have adverse effects. Maintaining the contaminated groundwater within the boundaries of Area B significantly reduces the potential for adverse effects to human health and the environment. The mobility of soil contaminants through the unsaturated zone would not be reduced with this alternative.

Influent and effluent storage tanks would be included in the equipment associated with this remedial alternative. These tanks allow samples that represent average influent and effluent concentrations to be taken. Sampling results could be sent to regulatory agencies to confirm compliance with permits.

Environmental impacts associated with this remedial action are likely to be comparable to the no-action alternative, assuming all discharges are in compliance with a NPDES permit. However, it is possible that the wells could pump unanticipated contaminants that are not removed by the treatment system (e.g., metals at concentrations that could pose a risk to surface water receptors). Such contamination could be mitigated by comprehensive analysis.

4.4.5. Reduction of Toxicity, Mobility, and Volume Through Treatment

This remedial alternative would reduce the toxicity, mobility, and volume of contaminants in groundwater through the extraction of contaminated groundwater and the destruction of VOCs.

The UV/oxidation unit specified for this site could efficiently destroy the VOCs to the PRGs. All extracted groundwater would be treated to levels that will comply with the requirements of an NPDES permit. Because the VOCs in the extracted groundwater are destroyed, the treatment is not reversible.

In areas where infiltration is not controlled, the contaminants found in the unsaturated zone would be reduced over time through leaching into the groundwater and from natural degradation processes. Their mobility would not be reduced with this treatment technology. The contaminants in the soil would continue to act as a source even after the removal of several pore volumes of groundwater. However, the recovery wells would create a hydraulic barrier that would prohibit most groundwater from moving offsite.

4.4.6. Implementability

This remedial alternative

- uses standard construction techniques,
- has been proven to run with minimal operating problems at other sites,
- uses standard equipment that can be obtained from multiple vendors, and
- can be operated by site personnel after an orientation by the selected vendor.

Disposal would consist of an NPDES-permitted discharge to the Great Miami River. The discharge volumes (45 gpm) would be a small increment in the current NPDES discharge.

4.4.7. Cost

The capital cost for Alternative 4 is $567,000. The annual O&M cost is $61,000 and the 30-year O&M cost is $1,170,000. The total cost is $1,740,00 (plus the common costs presented in Alternative 2).

4.5. ALTERNATIVE 5 - SURFACE CAP WITH COLLECTION, TREATMENT, AND DISPOSAL

Alternative 5 consists of groundwater collection, onsite treatment of extracted groundwater, and NPDES-permitted disposal of treated groundwater. In addition, a surface cap would be placed over suspected source areas to prevent infiltration of precipitation. This surface cap would augment the existing cap over the site sanitary landfill and would consist of a 6-inch leveling layer, 18 inches of low- permeable soil, and 6 inches of topsoil.

Under this alternative, groundwater would be extracted from two wells (Figure 3.1) and pumped to an influent storage tank to allow system stabilization and influent sampling representative of the average concentrations entering the treatment equipment. Groundwater with added hydrogen peroxide would then be pumped from the influent storage tank to an UV/oxidation unit where the VOCs would be destroyed (Figure 4.1). In the oxidation unit, a low-pressure UV lamp assembly would irradiate the groundwater as it passes through. The UV radiation would produce hydroxyl radicals from the added hydrogen peroxide; the organic contaminants would be oxidized by these hydroxyl radicals causing their decomposition into carbon dioxide, water, halides, and in some cases, organic acids (EPA 1993b). The treated groundwater would be pumped to the effluent storage tank to allow for effluent sampling prior to an NPDES-permitted discharge to the Great Miami River.

4.5.1. Compliance with ARARs

The UV/oxidation unit would be designed to meet ARARs. Under this alternative, all discharges would be monitored to ensure that they meet requirements set by the NPDES permit, which must be obtained prior to startup of the remedial action. The remedial action would be operated until the COC groundwater concentrations are at or below risk-based PRGs.

4.5.2. Short-Term Effectiveness

The community and workers could be exposed to COCs during the construction and/or installation of the remedial equipment and operation of the treatment equipment caused by the volatilization of groundwater during the treatment process. In order to minimize the possibility of any exposure,

- continuous air monitoring would be performed during all construction and/or installation work and if necessary, appropriate mitigation measures would be employed; and
- all equipment in the treatment process would be sealed (with appropriate venting for tanks) to prevent volatilization of contaminants.

No significant environmental impacts are expected as a result of this remedial action.

4.5.3. Long-Term Effectiveness and Permanence

UV/oxidation has been proven effective for the destruction of VOCs in extracted water at many sites. The destruction efficiencies required to meet typical NPDES permit discharge limits is attainable. The system would be designed so that the monitoring required to determine influent and effluent concentrations would be easily accomplished.

The UV/oxidation system requires regular maintenance by trained personnel, which would include cleaning the low-pressure UV lamp assembly and replacing components when needed. Cleaning frequency would range from once per month to once every three months depending on the concentration of suspended solids in the influent or formed during treatment (EPA 1993b). The low-pressure UV lamps require replacement every 3,000 hours to maintain maximum efficiency of operation (EPA 1993b). Other components of the system such as valves, gaskets, pipings, the hydrogen peroxide feed module, and pumps should be checked for leaks and proper operation once per month (EPA 1993b).

No toxic residuals would be produced; therefore, the future liabilities associated with offsite disposal do not need to be considered.

Simplified calculations using ambient groundwater velocity and VOC retardation coefficients indicate that groundwater would move through Area B as much as 30 times faster than the VOC contaminants (Appendix E), suggesting that many pore volumes of groundwater would have to be removed from beneath Area B to achieve PRGs. Due to the uncertainties of estimating contaminant flux through the unsaturated zone and contaminant desorption/adsorption on the aquifer matrix, prediction of the lifetime of remedial action is indeterminate without additional characterization of the source, unsaturated zone, and geochemistry.

The presence of the surface cap may reduce flux of contaminants from the unsaturated zone into the groundwater leaving more residual contamination in the unsaturated zone beneath the capped areas. Because there would be less contamination entering the groundwater system over time, less contaminant mass would ultimately have to be removed by the recovery wells in order to achieve PRGs. This reduction of soil contaminant mobility may therefore reduce the time until PRGs are met compared to Alternative 4, which does not include a surface cap.

4.5.4. Overall Protection of Human Health and Environment

Extracting groundwater significantly reduces the potential for offsite contaminant migration, and maintaining the groundwater contaminants within the boundaries of Area B significantly reduces the potential for adverse effects to human health and the environment. The presence of the cap would also restrict access to residual soil contamination and therefore reduce potential risks from soil exposure.

Influent and effluent storage tanks would be included in the equipment associated with this remedial alternative. These tanks would allow samples to be taken that represent average influent and effluent concentrations. Sampling results could be sent to regulatory agencies to confirm compliance with permits.

The addition of a surface cap could reduce potential ecological risks by decreasing the potential for biointrusion on the contents of the landfill. However, as with the previous alternative, there could be discharges of unanticipated contaminants to surface water receptors.

4.5.5. Reduction of Toxicity, Mobility, and Volume Through Treatment

This remedial alternative would reduce the toxicity, mobility, and volume of contaminants in groundwater by extracting contaminated groundwater and destroying VOCs. The mobility of the soil contaminants would be reduced by implementing the surface cap.

The UV/oxidation unit specified for this site can efficiently destroy the VOCs to the PRGs. All extracted groundwater would be treated to levels that will comply with the requirements typical of an NPDES permit. Because the VOCs in the extracted groundwater are destroyed, the treatment is not reversible.

The contaminants in the soil would continue to act as a source even after the removal of several pore volumes. However, the recovery wells would create a hydraulic barrier that prohibits most groundwater from moving offsite. The presence of the surface cap would reduce the amount of infiltration and consequently reduce contaminant movement from the unsaturated zone into the groundwater.

4.5.6. Implementability

This remedial alternative

- uses standard construction techniques,
- has been proven to run with minimal operating problems at other sites,
- uses standard equipment that can be obtained from multiple vendors, and
- can be operated by site personnel after an orientation by the selected vendor.

Disposal would consist of an NPDES-permitted discharge to the Great Miami River. The discharge volumes would be well within permit limitations.

4.5.7. Cost

The capital cost for Alternative 5 is $857,000. The annual O&M cost is $80,000 and the 30-year O&M cost is $1,530,000. The total cost is $2,390,000 (plus the common costs from Alternative 2).

4.6. ALTERNATIVE 6 - CONTAINMENT, COLLECTION, TREATMENT, AND DISPOSAL

Alternative 6 consists of subsurface containments groundwater collection, onsite treatment of extracted groundwater, and NPDES-permitted disposal of treated groundwater. Under this alternative, slurry columns would be installed on the southern and western edges of the landfill to prevent offsite migration of groundwater. Installation would be accomplished with a crane-mounted augering system that uses deep mixing of soil.

Within Area B, groundwater would be extracted from three wells at a total rate of approximately 12 gpm (Figure 3.4). Another groundwater extraction well would be located outside of the containment barrier south of Area B to recover contaminated groundwater in this area, if needed. The pumping rates of the wells inside the containment will be low compared to the pumping rates without containment presented in Alternatives 4 and 5 because their primary purpose is to maintain a hydraulic gradient across the subsurface barriers toward Area B. The extraction rate for the well south of Area B would also be low because the hydraulic gradient would be relatively flat due to the blockage of groundwater flow just upgradient. This well is expected to be a temporary installation, operating only until groundwater contamination outside the barrier has been removed.

The extracted groundwater from all wells would be pumped to an influent storage tank to allow system stabilization and influent sampling representative of the average concentrations entering the treatment equipment. Groundwater with added hydrogen peroxide would then be pumped from the influent storage tank to an UV/oxidation unit where the VOCs would be destroyed (Figure 4.1). In the

oxidation unit, a low-pressure UV lamp assembly would irradiate the groundwater as it passed through. The UV radiation would produce hydroxyl radicals from the added hydrogen peroxide. The organic contaminants would be oxidized by the hydroxyl radicals, causing their decomposition into carbon dioxide, water, halides, and in some cases, organic acids (EPA 1993b). The treated groundwater would then be pumped to the effluent storage tank to allow for effluent sampling prior to an NPDES-permitted discharge to the Great Miami River.

4.6.1. Compliance with ARARs

The UV/oxidation unit would be designed so that ARARs are met. All discharges would be monitored to ensure that discharges are meeting the requirements set by the NPDES permit, which must be obtained prior to startup of the remedial action. The remedial action would be operated until the COC groundwater concentrations are at or below risk-based PRGs.

4.6.2. Short-Term Effectiveness

The community and workers could be exposed to COCs during the construction/installation of the remedial equipment and the slurry columns, and volatilization of groundwater during the treatment process. In order to minimize the possibility of any exposure, the following procedures would be implemented:

- Continuous air monitoring would be performed during all construction and/or installation work and if necessary, appropriate mitigation measures would be employed.
- All equipment in the treatment process would be sealed to prevent volatilization of contaminants.

In addition, workers may be exposed to subsurface contaminants during the installation of the slurry columns. The types of contaminants and their concentrations in the subsurface of the proposed slurry column locations would have to be characterized with soil borings prior to slurry column installation. To minimize worker risk, the slurry columns would need to be placed beyond the limits of buried, contaminated material, such as the crushed drums.

The slurry columns installation will most likely generate small amounts of contaminated soils. These soils must be disposed of appropriately. Future liabilities associated with such an action must be considered.

No significant environmental impacts are expected as a result of this remedial action.

4.6.3. Long-Term Effectiveness and Permanence

UV/oxidation has been proven effective for the destruction of VOCs in extracted water at many sites. The destruction efficiencies required to meet typical NPDES permit discharge limits would be easily obtainable. The system would be designed so that the monitoring required to determine influent and effluent concentrations will be easily accomplished.

The UV/oxidation system requires regular maintenance by trained personnel, which would include cleaning the low-pressure UV lamp assembly and replacing components when needed. Cleaning frequency would range from once per month to once every three months depending on the concentration of suspended solids formed during treatment or in the influent (EPA 1993b). The low-pressure UV lamps require replacement every 3,000 hours to maintain maximum efficiency of operation (EPA 1993b). Other components of the system such as valves, gaskets, pipings, the hydrogen peroxide feed module, and pumps should be checked for leaks and proper operation once per month (EPA 1993b).

4.6.4. Overall Protection of Human Health and Environment

The combination of groundwater recovery and a subsurface barrier around Area B would significantly reduce the potential for offsite contaminant migration. Furthermore, if the extraction system is shut down, the subsurface barrier would temporarily prevent the potential for offsite migration of groundwater. The subsurface barrier may expedite the remediation by reducing the amount of uncontaminated groundwater extracted. Maintaining the groundwater contaminants within the boundaries of Area B would significantly reduce the potential for adverse effects on human health and the environment.

Influent and effluent storage tanks would be included in the equipment associated with this remedial alternative. These tanks will allow samples to be taken that represent average influent and effluent concentrations. Sampling results could be sent to regulatory agencies to confirm compliance with permits.

As with any discharge into surface water, a potential to release unanticipated contaminants exists that may impact surface water receptors.

4.6.5. Reduction of Toxicity, Mobility, and Volume Through Treatment

This remedial alternative would reduce the toxicity, mobility, and volume of groundwater by extracting contaminated groundwater and destroying of VOCs. The presence of the subsurface barrier will also limit groundwater mobility by preventing offsite migration during shutdowns. If groundwater recovery is shutdown for an extended period, groundwater may flow around the subsurface barrier allowing contaminants to migrate offsite.

The UV/oxidation unit specified for this site can efficiently destroy the VOCs to the PRGs. All extracted groundwater would be treated to levels that will comply with the requirements of an NPDES permit. Because the VOCs in the extracted groundwater are destroyed, the treatment is not reversible.

In areas where infiltration is not controlled, the contaminants found in the unsaturated zone would be reduced over time through leaching into the groundwater. The movement of contaminants into the groundwater will continue to act as a source even after the removal of several Area B aquifer pore volumes. Groundwater contaminant volume and mobility would be reduced by groundwater recovery within subsurface barriers and groundwater recovery south of Area B.

4.6.6. Implementability

This remedial alternative

- uses standard construction techniques,
- has been proven to run with minimal operating problems at other sites,
- uses standard equipment that can be obtained from multiple vendors, and
- can be operated by site personnel after an orientation by the selected vendor.

Disposal will consist of an NPDES-permitted discharge to the Great Miami River. Obtaining a permit for this remedial alternative may be difficult due to the expected lifetime of the remedial action. The discharge volumes would be well within the permit limitations.

4.6.7. Cost

The capital cost for Alternative 6 is $1,330,000. The annual O&M cost is $69,000 and the 30-year O&M cost is $1,320,000. The total cost is $2,650,000 (plus the common cost from Alternative 2).

4.7. ALTERNATIVE 7 - SURFACE CAP WITH CONTAINMENT, COLLECTION, TREATMENT, AND DISPOSAL

Alternative 7 consists of a surface cap, subsurface containment, groundwater collection, onsite treatment of extracted groundwater, and NPDES-permitted disposal of treated groundwater. A surface cap would be placed over suspected source areas to reduce infiltration of precipitation. The surface cap, which would augment the existing cap over the site sanitary landfill, would consist of a 6-inch leveling layer, 18 inches of low-permeable soil, and 6 inches of topsoil. Slurry columns would be installed on the southern and western edges of the landfill to prevent offsite migration of groundwater. Installation would be accomplished with a crane-mounted augering system that uses deep soil-mixing.

Within Area B, groundwater would be extracted from three wells at a total rate of approximately 12 gpm (Figure 3.4). Another groundwater extraction well would be located outside of the containment barrier south of Area B to recover contaminated groundwater in this area if needed. The pumping rates of the wells inside the containment would be low compared to the pumping rates without containment in Alternatives 5 and 6 because their primary purpose is to maintain a hydraulic gradient across the subsurface barriers toward Area B. The extraction rate for the well south of Area B would be low because of the relatively flat hydraulic gradient, which is a result of the blockage of groundwater flow just upgradient. This well is expected to be a temporary installation, operating only until groundwater contamination outside the barrier has been removed.

The extracted groundwater would be pumped to an influent storage tank to allow system stabilization and influent sampling representative of the average concentrations entering the treatment equipment. Groundwater with added hydrogen peroxide would then be pumped from the influent storage tank to a UV/oxidation unit where the VOCs would be destroyed (Figure 4.1). In the UV/oxidation unit, a low-pressure UV lamp assembly would irradiate the groundwater as it passed through, and the UV radiation would produce hydroxyl radicals from the added hydrogen peroxide. The organic contaminants would be oxidized by the hydroxyl radicals, causing their decomposition into carbon dioxide, water, halides, and in some cases, organic acids (EPA 1993b). The treated groundwater would then be pumped to the effluent storage tank to allow for effluent sampling prior to an NPDES-permitted discharge into the Great Miami River.

4.7.1. Compliance with ARARs

The UV/oxidation unit would be designed so that ARARs are met. All discharges would be monitored to ensure that they meet the requirements set by the NPDES permit, which must be obtained prior to

startup of the remedial action. This remedial action would be operated until the COC groundwater concentrations are at or below risk-based PRGs.

4.7.2. Short-Term Effectiveness

The community and workers could be exposed to COCs during the construction/installation of the remedial equipment and the slurry columns, as well as volatilization of groundwater during the treatment process. In order to mitigate the possibility of any exposure, the following procedures would be implemented:

- Continuous air monitoring would be performed during all construction and installation work, and, if necessary, appropriate mitigation measures would be employed.
- All equipment in the treatment process would be sealed to prevent volatilization of contaminants.

In addition, workers may be exposed to subsurface contaminants during the installation of the slurry columns. The types of contaminants and their concentrations in the subsurface of the proposed slurry column locations would have to be characterized with soil borings prior to slurry column installation. To minimize worker risk, the slurry columns would be placed beyond the limits of buried, contaminated material, such as the crushed drums.

The slurry columns installation would most likely generate contaminated soils that must be disposed of appropriately. Future liabilities associated with such an action need to be considered.

No significant environmental impacts are expected as a result of this remedial action.

4.7.3. Long-Term Effectiveness and Permanence

UV/oxidation has been proven effective for the destruction of VOCs in extracted water at many sites. The destruction efficiencies required to meet typical NPDES-permit discharge limits would be easily obtainable. The system would be designed so that the monitoring required to determine influent and effluent concentrations would be easily accomplished.

The UV/oxidation system requires regular maintenance by trained personnel, including cleaning the low-pressure UV lamp assembly and replacing components when needed. Cleaning frequency would range from once per month to once every three months depending on concentration of suspended solids in the influent or formed during treatment (EPA 1993b). The low-pressure UV lamps require replacement

every 3,000 hours to maintain maximum efficiency of operation (EPA 1993b). Other components of the system such as valves, gaskets, pipings, the hydrogen peroxide feed module, and pumps should be checked for leaks and proper operation once per month (EPA 1993b).

Due to the uncertainties of estimating contaminant flux through the unsaturated zone and contaminant desorption/adsorption, prediction of the lifetime of remedial action is indeterminate without additional source, unsaturated zone, and geochemical characterization.

The installation of the slurry columns would reduce the lifetime of the remedial action by limiting the amount of offsite groundwater that would be recovered by the extraction wells. The presence of the surface cap would also reduce the flux of contaminants from the unsaturated zone into the groundwater leaving more residual contamination in the unsaturated zone beneath the capped areas. Because less contamination would enter the groundwater system over time, less contaminant mass would ultimately have to be removed by the recovery wells in order to achieve PRGs. This reduction of soil contaminant mobility would therefore reduce the time until PRGs are met compared to Alternative 6, which does not include use of a surface cap.

4.7.4. Overall Protection of Human Health and Environment

The combination of groundwater recovery and a subsurface barrier around Area B would significantly reduce the potential for offsite contaminant migration. Furthermore, if the extraction system is shut down, the subsurface barrier would temporarily prevent the potential for offsite migration of groundwater. The subsurface barrier may expedite the remediation by reducing the amount of uncontaminated groundwater extracted. Maintaining the groundwater contaminants within the boundaries of Area B would significantly reduce the potential for adverse effects to human health and the environment. The presence of the cap would restrict access to residual soil contamination and decrease the amount of contaminant leaching.

The addition of a surface cap could also reduce potential ecological risks by decreasing the potential for biointrusion on the contents of the landfill. However, as with the previous alternative, there could be discharges of unanticipated contaminants to surface water receptors.

Influent and effluent storage tanks would be included in the equipment associated with this remedial alternative. These tanks would allow samples to be taken that represent average influent and effluent concentrations. Sampling results could be sent to regulatory agencies to confirm compliance with permits.

4.7.5. Reduction of Toxicity, Mobility, and Volume Through Treatment

This remedial alternative would reduce the toxicity, mobility, and volume of groundwater through the extraction of contaminated groundwater and the destruction of VOCs. The presence of the slurry columns and surface cap would also limit groundwater mobility by preventing offsite migration during shutdowns and by limiting surface infiltration. If the equipment is shut down for an extended period, groundwater will most likely flow around the columns allowing contaminants to migrate offsite.

The UV/oxidation unit specified for this site can efficiently destroy the VOCs to the PRGs. All extracted groundwater will be treated to levels that will comply with the requirements of an NPDES permit. Because the VOCs in the extracted groundwater are destroyed, the treatment is not reversible.

The presence of the surface cap may reduce the amount of infiltration and consequently reduce contaminant movement from the unsaturated zone into the groundwater. Groundwater contaminant volume and mobility would be reduced by groundwater recovery within subsurface barriers and groundwater recovery south of Area B.

4.7.6. Implementability

Once construction surveys have been performed for the slurry columns, this remedial alternative

- uses standard construction techniques,
- has been proven to run with minimal operating problems at other sites,
- uses standard equipment that can be obtained from multiple vendors, and
- can be operated by site personnel after an orientation by the selected vendor.

Disposal would consist of an NPDES-permitted discharge into the Great Miami River. The discharge volumes would be well within the permit limitations.

4.7.7. Cost

The capital cost for Alternative 7 is $1,620,000. The annual O&M cost is $88,000 and the 30-year O&M cost is $1,680,000. The total cost is $3,300,000 (plus the common costs from Alternative 2).

4.8. ALTERNATIVE 8 - *IN SITU* GROUNDWATER TREATMENT

Alternative 8 consists of *in situ* treatment of groundwater with the use of a subsurface permeable treatment wall composed of iron filings and sand. As part of this treatment alternative, slurry columns would be installed on the southern and western boundaries of Area B to reduce offsite migration of groundwater and to direct groundwater flow through the permeable treatment wall on the southwest perimeter of Area B (Figure 3.5). The treatment wall would cause abiotic degradation of the VOCs and could potentially remove some of the metals as the groundwater passes through it.

The slurry columns would be installed with a crane-mounted augering system that uses deep soil mixing while the treatment wall would be installed with the use of a backhoe and sheet pilings. If future groundwater monitoring showed that gradient modification was needed to divert more groundwater flow through the treatment wall, an enhancement may consist of positioning an extraction well outside the treatment wall. The resultant drawdown would increase the gradient through the treatment wall. An extraction well in this location may also be used to recover any groundwater contamination south of the containment barrier if necessary.

4.8.1. Compliance with ARARs

The permeable treatment wall would be designed so that all applicable ARARs are met. Monitoring would be performed downgradient of the treatment wall to ensure that it is functioning properly. The remedial action would be operated until the COC groundwater concentrations within Area B were at or below risk-based PRGs. If a recovery well outside of the treatment wall was used, the contaminant concentrations in the extracted groundwater would be diluted because the capture zone would primarily intercept noncontaminated groundwater. This water would most likely be acceptable for NPDES discharge.

4.8.2. Short-Term Effectiveness

The community and workers could be exposed to the COCs caused by the construction/installation of the permeable wall and slurry columns.

In order to minimize the possibility of any exposure, continuous air monitoring would be performed during all construction/installation work, and, if necessary, appropriate mitigation measures would be employed. In addition, the type of contaminants and their concentrations in the subsurface in the proposed areas of the slurry columns would have to be characterized with soil borings prior to permeable wall and slurry column installation.

The permeable treatment wall and slurry columns installation would generate contaminated soils, which must be disposed of appropriately. Future liabilities associated with such an action must be considered. The treatment wall and slurry columns would be placed beyond the limits of buried contaminated material, such as the crushed drums.

If a recovery well south of the treatment wall is used, it most likely would be a short-term remedial measure active only long enough to remove VOCs south of Area B. Because no groundwater contaminant source is present south of Area B, the recovery time would be much less compared to that for recovery within Area B.

Installation of a treatment wall would involve excavation of a relatively small area, impacting the biota of that area. However, this is not likely to be a significant impact to the environment.

4.8.3. Long-Term Effectiveness and Permanence

The permeable treatment wall would be designed so that the VOC degradation required to meet PRGs would be obtainable. Monitoring wells would be installed so that the quality of groundwater exiting the treatment wall could be easily monitored. If PRGs were exceeded in groundwater flowing out of the permeable treatment wall, the wall material would be excavated and replaced.

Soil contamination in the unsaturated zone would be reduced over the long term by leaching into the groundwater. Due to the uncertainties of estimating contaminant flux through the unsaturated zone and contaminant adsorption on and desorption from the aquifer matrix, prediction of the lifetime of remedial action is indeterminate without additional source, unsaturated zone, and geochemical characterization.

A remedial action using a permeable treatment wall as the treatment technology would take longer to reach treatment goals than an active pumping technology because no active removal of contaminated groundwater will be employed. This passive alternative offers more permanence than an active pumping alternative because it does not rely on external energy sources to function.

4.8.4. Overall Protection of Human Health and Environment

Potential for human and environmental exposure would be greatly reduced over active pumping technologies because only treated groundwater would be allowed to migrate offsite. The contaminant concentrations in this groundwater would be protective of human health and the environment.

Existing or new monitoring wells upgradient and downgradient of the treatment wall would allow groundwater samples to be taken. These samples would determine whether the permeable wall is functioning correctly. Sampling results could be sent to regulatory agencies to confirm compliance with operating agreements.

This alternative has the advantage of less potential for environmental impact because it does not involve discharge to surface water.

4.8.5. Reduction of Toxicity, Mobility, and Volume Through Treatment

The presence of the permeable treatment wall would reduce the toxicity of the groundwater by degrading the VOCs that pass through it. The presence of the slurry columns would reduce the mobility of the contaminated groundwater by reducing offsite migration. The volume of contaminated groundwater would be reduced slowly over a long time as the groundwater passes through the permeable wall.

The permeable wall would be designed so degradation efficiencies meet PRGs. Because the VOCs are degraded as they pass through the permeable treatment wall, the treatment is not reversible.

In areas where infiltration is not controlled, the contaminants found in the unsaturated zone would continue to infiltrate into the groundwater.

4.8.6. Implementability

This remedial alternative

- has been proven effective with pilot scale studies (EPA 1993c, Gillham et. al., 1993), but has never been implemented on a full scale remedial action,
- requires preconstruction exploration borings prior to implementation,
- uses standard construction materials and techniques, and
- requires very little site maintenance.

The only disposal requirements associated with the permeable treatment wall and slurry columns would be from the construction and installation stages. If a short-term recovery well is used, the extracted groundwater would most likely meet NPDES discharge requirements.

4.8.7. Cost

The capital cost for Alternative 8 is $1,650,000. The annual O&M cost is $17,000, and the 30-year O&M cost is $325,000. The total cost is $1,980,000 (plus the common costs from Alternative 2).

4.9. ALTERNATIVE 9 - SURFACE CAP AND *IN SITU* GROUNDWATER TREATMENT

Alternative 9 consists of a surface cap and *in situ* treatment of groundwater with the use of a subsurface permeable treatment wall composed of iron filings. As part of this treatment alternative, slurry columns would be installed on the southern and western boundaries of Area B to reduce offsite migration of groundwater and to direct groundwater flow through the permeable treatment wall on the southwest perimeter of Area B (Figure 3.5). The treatment wall causes degradation of the VOCs and removes some of the metals as the groundwater passes through it.

The slurry columns would be installed with a crane-mounted augering system that uses deep soil mixing. The treatment wall would be installed with the use of a backhoe and sheet pilings. If necessary, an extraction well would be located south of Area B outside of the permeable treatment wall to effect groundwater flow through the permeable treatment wall. This well would also be in a position to recover contaminated groundwater south of Area B outside of the subsurface barrier.

4.9.1. Compliance with ARARs

The permeable treatment wall would be designed so that all applicable ARARs are met. Monitoring would be performed downgradient of the treatment wall to ensure that it functions correctly. This remedial action would be operated until the COC groundwater concentrations inside the landfill are at or below risk-based PRGs.

4.9.2. Short-Term Effectiveness

The community and workers would be exposed to COCs during the construction/installation of the permeable wall and slurry columns.

In order to minimize the possibility of any exposure, continuous air monitoring would be performed during all construction/installation work; and, if necessary, appropriate mitigation measures would be employed. In addition, the magnitude and type of contaminants found in the subsurface would be characterized with soil borings prior to the installation of the permeable wall and slurry columns. The

treatment wall and slurry columns would be placed beyond the limits of buried contaminated material, such as the crushed drums.

The permeable treatment wall and slurry columns installation would most likely generate contaminated soils, which would be disposed of appropriately. Future liabilities associated with such an action need to be considered.

Installation of a treatment wall would involve excavation of a relatively small area, which would impact the biota of that area. However, this is not likely to be a significant impact to the environment.

4.9.3. Long-Term Effectiveness and Permanence

The permeable treatment wall would be designed so that VOC degradation required to meet PRGs would be easily obtainable. Monitoring wells would be installed so that groundwater quality exiting the treatment wall could be monitored easily. If PRGs are exceeded in groundwater flowing out of the permeable treatment wall, the wall material may be excavated and replaced.

Soil contamination in the unsaturated zone would be reduced over the long term by leaching into the groundwater. Due to the uncertainties of estimating contaminant flux through the unsaturated zone and contaminant desorption/adsorption on the aquifer matrix, prediction of the lifetime of remedial action is indeterminate without additional source, unsaturated zone, and geochemical characterization.

A remedial action using a permeable treatment wall as the treatment technology would take longer to reach treatment goals than a pump-and-treat technology because no active removal of contaminated groundwater will be employed. The surface cap may reduce the flux of contaminants from the unsaturated zone into the groundwater. This passive alternative offers more permanence than a pump-and-treat alternative because it does not rely on external energy sources to function.

4.9.4. Overall Protection of Human Health and Environment

Potential for human and environmental contamination exposure would be greatly reduced over pump-and-treat technologies, because only treated groundwater would be allowed to migrate offsite. The contaminant levels in this groundwater would not be dangerous to human health and the environment. This alternative has the advantage of less potential for environmental impact because it does not involve discharge to surface water.

The presence of the cap would reduce soil contaminant mobility and decrease the potential for exposure to soil contaminants. The addition of a surface cap could also reduce potential ecological risks by decreasing the potential for biointrusion on the contents of the landfill.

Monitoring wells would be installed upgradient and downgradient of the permeable wall to allow samples to be taken. These samples would determine whether the permeable treatment wall is functioning correctly. Sampling results could be sent to regulatory agencies to confirm compliance with operating agreements.

4.9.5. Reduction of Toxicity, Mobility, and Volume Through Treatment

The presence of the permeable treatment wall would reduce the toxicity of the groundwater by degrading the VOCs that pass through it. The presence of the slurry columns would reduce the mobility of the contaminated groundwater by reducing offsite migration. The volume of contaminated groundwater would be reduced slowly over time as the groundwater passes through the permeable wall.

The permeable wall would be designed so degradation efficiencies meet PRGs. Because the VOCs are degraded as they pass through the permeable treatment wall, the treatment is not reversible.

4.9.6. Implementability

This remedial alternative

- has been proven effective with pilot scale studies, but has never been implemented on a full-scale remedial action,
- requires preconstruction exploration borings prior to implementation,
- uses standard construction materials and techniques, and
- requires very little site maintenance.

The only disposal requirements associated with the permeable treatment wall and slurry columns would be during the construction and/or installation stages.

Selection of this remedial alternative may be difficult because a permeable treatment wall has never been constructed for a full-scale remedial action.

4.9.7. Cost

The capital cost for Alternative 9 is $1,940,000. The annual O&M cost is $36,000 and the 30-year O&M cost is $688,000. The total cost is $2,630,000 (plus the common costs from Alternative 2).

4.10. SUMMARY AND COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

This section provides a comparative analysis of the alternatives in which the relative performance of each alternative in relation to the evaluation criteria is described. The purpose of this section is to identify the relative advantages and disadvantages of each alternative. A summary of these comparisons is given in Table IV.3.

4.10.1. Compliance with ARARs

The chemical-specific and action-specific ARARs were presented in Section 2 of this report. All alternatives, except the no-action and institutional controls alternatives, were designed to meet all of the ARARs. Under the no-action and institutional controls alternatives, ARARs would be exceeded at the point of compliance.

4.10.2. Short-Term Effectiveness

Alternatives 5, 7, and 9 provide the greatest short-term effectiveness because immediately after installation, the surface cap would prevent contact with contaminated soils. Some dust generation is expected during installation of the cap; however, this risk could be easily reduced by dust control methods and worker protection. The cap would also rapidly reduce leachate movement from the unsaturated zone into the groundwater.

Alternatives 3, 4, 6, and 8, which do not include a surface cap but do include a fence around Area B, would have little short-term effectiveness because contact with contaminated soils would not be completely prevented. Potentially, onsite workers would be exposed to contaminated soils, and the community potentially could be exposed to COCs through airborne dust.

Environmental impacts common to all alternatives include disturbance of biota in the areas of construction. However, these would not be significant environmental impacts.

Table IV.3. Summary of Remedial Action Alternative Comparison

Alternative	Short Title	Complies With ARARs	Short-term Effectiveness	Long-term Effectiveness	Protects Human Health and the Environment	Reduces TMV	Implementability	Total Cost
1	No Action	No	No	No	No	No	Easy	$0
2	Institutional	No	No	No	No	No	Easy	$3,980,000
3	Collect/ Disposal	Yes	Adequate[a]	Yes	Adequate	Yes	Less Difficult	$262,000[c]
4	Collect/Treat/ Disposal	Yes	Adequate[a]	Yes	Adequate	Yes	Less Difficult	$1,740,000[c]
5	Collect/Treat/ Disposal/Cap	Yes	Adequate[b]	Yes	Adequate	Yes	Less Difficult	$2,390,000[c]
6	Contain/Collect/ Treat/Disposal	Yes	Adequate[b]	Yes	Adequate	Yes	Moderately Difficult	$2,650,000[c]
7	Contain/Collect/ Treat/Disposal/ Cap	Yes	Adequate[b]	Yes	Adequate	Yes	Moderately Difficult	$3,300,000[c]
8	In-situ GW Treatment	Yes	Adequate[b]	Yes	Adequate	Yes	More Difficult	$1,980,000[c]
9	In-situ GW Treatment/Cap	Yes	Adequate[b]	Yes	Adequate	Yes	More Difficult	$2,630,000[c]

[a]Quickest implementation when compared to other alternatives.
[b]Longer construction time when compared to other alternatives.
[c]This Total Cost is in addition to the Total Cost shown for Alternative 2 (common cost).
ARARs - Applicable or relevant and appropriate requirements.
TMV - Toxicity, mobility, or volume.

4.10.3. Long-Term Effectiveness and Permanence

Alternatives 7 and 9 provide the highest degrees of long-term effectiveness and permanence because they use a subsurface containment system (slurry columns) to passively reduce movement of contaminated groundwater offsite. Alternative 7 also employs groundwater recovery wells to extract contaminated groundwater from Area B and to ensure a hydraulic gradient toward Area B. Groundwater recovery wells would be effective over the long term at fulfilling these tasks. The permanence of these alternative would also be considered high, because once the PRGs are met, groundwater contamination would remain onsite. These alternatives also utilize a surface cap to passively reduce leachate movement from the unsaturated zone. This technology would contribute to the high degree of effectiveness and permanence of these alternatives due to the resultant decrease in contaminant flux from the unsaturated zone.

Alternatives 6 and 8 also employ subsurface containment systems (slurry columns) around Area B. However, because these do not implement a surface cap to control contaminant flux from the unsaturated zone, their permanence would be considered less than Alternatives 7 and 9.

Alternatives 3, 4 and 5, which utilize groundwater recovery wells but no subsurface containment, would be less effective at preventing offsite movement of contaminated groundwater. Even if properly monitored and adjusted according to changing hydrogeologic conditions, a small amount of groundwater could potentially not be captured if one or more recovery wells were shut down for maintenance.

4.10.4. Overall Protection of Human Health and the Environment

Alternatives 5, 7, and 9 provide adequate protection of human health and the environment by reducing risk of soil contact and reducing risk of contaminated groundwater ingestion. Alternatives 3, 4, 6, and 8 reduce risk of contaminated groundwater ingestion but provide minimal reduction of soil contact risk.

Alternative 1 (no action) provides no protection of human health and the environment. Alternative 2 provides minimal reduction of the risk of contact with soil. Alternative 2 also provides some reduction of risk through groundwater ingestion onsite, but there is some uncertainty about the prevention of offsite groundwater ingestion.

4.10.5. Reduction of Mobility, Toxicity, and Volume Through Treatment

All alternatives except Alternatives 1, 2 and 3 reduce the mobility, toxicity, and volume of contaminated groundwater by employing UV/oxidation water treatment technology prior to its discharge through the NPDES-permitted outfall. This technology is reliable with proper O&M.

Alternative 1 (no action) and Alternative 2 (institutional controls) do not reduce mobility, toxicity, or volume of contaminated groundwater through treatment. Alternative 3 reduces only contaminant volume and mobility in the groundwater by implementing groundwater extraction.

4.10.6. Implementability

Technically, Alternative 2 would be the easiest to implement because it only involves construction of a fence only. However, this alternative would be the most difficult to implement administratively because of uncertainties involving acquisition of land or water rights to prevent groundwater ingestion.

Alternatives 3, 4 and 5 would be implementable using standard construction techniques and practices. The water treatment technology required in alternatives 4, 5, 6, and 7 is not widely used, but because it has been put into practice at several sites and is relatively uncomplicated to operate, it should be readily implementable.

Alternatives 5, 7 and 9, which involve the surface cap, would be less implementable than their counterparts that do not include a surface cap (Alternatives 4, 6 and 8, respectively). To make augmentation of the existing cap feasible, the low-permeability soil option was chosen since it was the best match to the existing cap and could be used to extend the cap over the desired areas with less disruption to the current containment system. Given the steep sides of the existing landfill, however, an added degree of difficulty exists in the design and implementation of the surface cap extension.

Alternatives 6 and 7, which involve construction of a subsurface barrier around Area B with slurry columns, would not be as readily implementable as the previous alternatives. This difficulty is because a soil-boring program for contaminant sampling and geotechnical testing must be conducted prior to slurry column installation. The slurry column installation would be implementable using common construction practices.

Alternatives 8 and 9, which involve subsurface barriers and a subsurface permeable treatment wall, would be less implementable than Alternatives 6 and 7 because treatability studies would be required

in order to design the permeable treatment wall. The slurry column construction for this alternative would be the same as described above.

4.11. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) CONSIDERATION

NEPA requires federal agencies to assess the impacts that their actions may have on the environment. Procedures for implementing the NEPA are contained in regulations issued by the Council on Environmental Quality in the Code of Federal Regulations (CFR), Title 40, Parts 1500 through 1508 (40 CFR 1500-1508). The DOE procedures for implementing the NEPA are contained in 10 CFR 1021 and various DOE notices, orders, and guidelines.

It is the legal position of the U.S. Department of Justice that the NEPA is not applicable to remedial actions performed by federal agencies under the CERCLA (Hartman 1991). However, the DOE has established an agency policy in DOE Order 5400.4 to integrate the requirements of the NEPA and the CERCLA RI/FS process for remedial actions. The primary instrument for this integration is the RI/FS process.

CERCLA documents such as an RI/FS evaluate many, but not all, of the environmental components that must be considered for compliance with the NEPA. For example, an RI/FS evaluates the effects of remedial action alternatives on surface water and groundwater resources but will not evaluate the effects on wetlands and threatened and endangered species. This section of the FS Report for Operable Unit 1 at the Mound Plant evaluates the environmental impacts of the remedial action alternatives that are not evaluated in other sections of the RI and FS Reports.

With the inclusion of this section, the FS Report will also constitute an environmental assessment (EA) of the proposed remedial action for Operable Unit 1, and the information and analyses presented here will be used to determine if the proposed remedial action would have a significant impact on the environment, within the meaning of the NEPA. If the impact is determined to be significant, an environmental impact statement will be prepared for the proposed remedial action. If the impact is judged to not be significant, an official "Finding of No Significant Impact" will be issued, and the proposed corrective action will be implemented.

4.11.1. Air Quality

The Mound Plant is within the Regional Air Pollution Control Agency (RAPCA). Through the EPA, OEPA, and local government delegation, the RAPCA is the air pollution control agency for the

Metropolitan Dayton Intrastate Air Quality Control Region in southwest Ohio. This region contains Darke, Miami, Clark, Preble, Montgomery, and Greene Counties (RAPCA 1993).

The National Ambient Air Quality Standards (40 CFR 50) have set the maximum acceptable concentrations for inhalable particulates, sulfur dioxide, lead, carbon monoxide, nitrogen dioxide, and ozone. The RAPCA monitors for all of these air pollutants except nitrogen dioxide (an ozone precursor), for which monitoring was discontinued in 1987. None of the RAPCA monitoring sites recorded any exceedances of the health-related air quality standards in 1992. From 1983 through 1992, most all of the monitoring sites had decreasing trends for all pollutant concentrations. One monitoring site had a slightly increasing trend for carbon monoxide, but the increase was not statistically significant (RAPCA 1993).

The OEPA has initiated the development of a toxic emission inventory, which includes toluene, xylene, methylene chloride, formaldehyde, chloroform, perchloroethylene, and cadmium and cadmium compounds. Major new industrial sources are routinely reviewed for toxic air emissions through the Permit to Install process. Each new point source is evaluated using OEPA guidance to ensure that a health risk is not created for nearby residents. RAPCA conducts ambient air toxics sampling of selected facilities (RAPCA 1993).

Since 1985, the Mound Plant has monitored and modeled the effective dose equivalent to the public from ambient air concentrations of plutonium-238, plutonium-239, tritium, uranium-234, and uranium-238. According to previous investigations (EG&G 1989, DOE 1979), the effects of radiological air emissions from the Mound Plant are considered to be small or negligible.

All of the remedial action alternatives except the no action alternative would involve some amount of surface disturbance in Operable Unit 1, which could result in the creation of airborne dust. The remedial action alternatives requiring only the completion of groundwater extraction wells would create the least amount of airborne dust while those involving a surface cap would create the most airborne dust. The surface disturbing activities would be temporary and of limited duration, and the amount of airborne dust created is not expected to affect the overall air quality in the area of the Mound Plant. However, the community and remedial action workers could be exposed to COCs through this airborne dust. Continuous air-monitoring would be performed during all surface disturbing activities, and appropriate mitigative measures would be implemented, if necessary, to minimize the possibility of exposure to airborne dust. The baseline risk assessment in the RI report (DOE 1994a) for Operable Unit 1 revealed that the risk of adverse health effects from contaminated soil in Operable Unit 1 is minimal.

Volatization of the COCs during treatment of the contaminated groundwater could release airborne contaminants, which could affect air quality and expose the community and remedial action workers. The baseline risk assessment in the RI report (DOE 1994a) for Operable Unit 1 revealed that the COCs in groundwater present the most risk for adverse health effects. To mitigate the possibility of any release of airborne contaminants during the groundwater treatment process, all equipment used in the treatment process would be sealed.

4.11.2. Floodplains and Wetlands

In 1979, the DOE established regulations in 10 CFR 1022 to comply with requirements for the environmental review of floodplains and wetlands. These regulations provide for compliance with Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, and are designed to be coordinated with the environmental review requirements of the NEPA. In accordance with the requirements of 10 CFR 1022, a preliminary wetlands assessment of the Mound Plant was performed in January 1992 (DOE 1992c), and onsite and offsite wetlands determinations were performed in August 1992 and May 1993, respectively (DOE 1994c). The methodology used to identify potential wetlands in the preliminary wetlands assessment was in accordance with Executive Order 11990 and 10 CFR 1022. The onsite and offsite wetlands determinations were conducted in accordance with the guidelines of the U.S. Army Corps of Engineers (Environmental Laboratory 1987). The purpose of the wetlands determinations was to identify potential wetland areas and waters of the United States (waterways) pursuant to Section 404 of the Clean Water Act.

Figure 4.2 shows the currently recognized 100-year floodplain of the Great Miami River in the vicinity of the Mound Plant. A very small area in the southwest corner of the plant and the abandoned Miami-Erie Canal lie within the floodplain. At its closest point, the 100-year floodplain is approximately 250 ft from Operable Unit 1, and none of the remedial action alternatives would have any adverse effects on the floodplain. Also, none of the remedial action alternatives constitute a "critical action" as defined in 10 CFR 1022.4(c) and (i); therefore, an analysis of the 500-year floodplain of the Great Miami River is not required.

The Overflow Pond within Operable Unit 1 has a surface area of 79,717 sq ft and an average depth of 4 to 6 ft. The purpose of the pond is to retain storm flows and settle sediment, thereby supporting compliance with NPDES discharge standards for suspended solids. The pond is built with earthen dikes and has a capacity of 5 million gallons. Water in the Overflow Pond is discharged through a standpipe in the northwest corner of the pond and eventually to the Miami-Erie Canal and Great Miami River through NPDES Outfall 002 at a rate of approximately 660,000 gallons per day (Mound 1990). The plant community around the margin of the pond is not dominated by hydrophytic vegetation (i.e.,

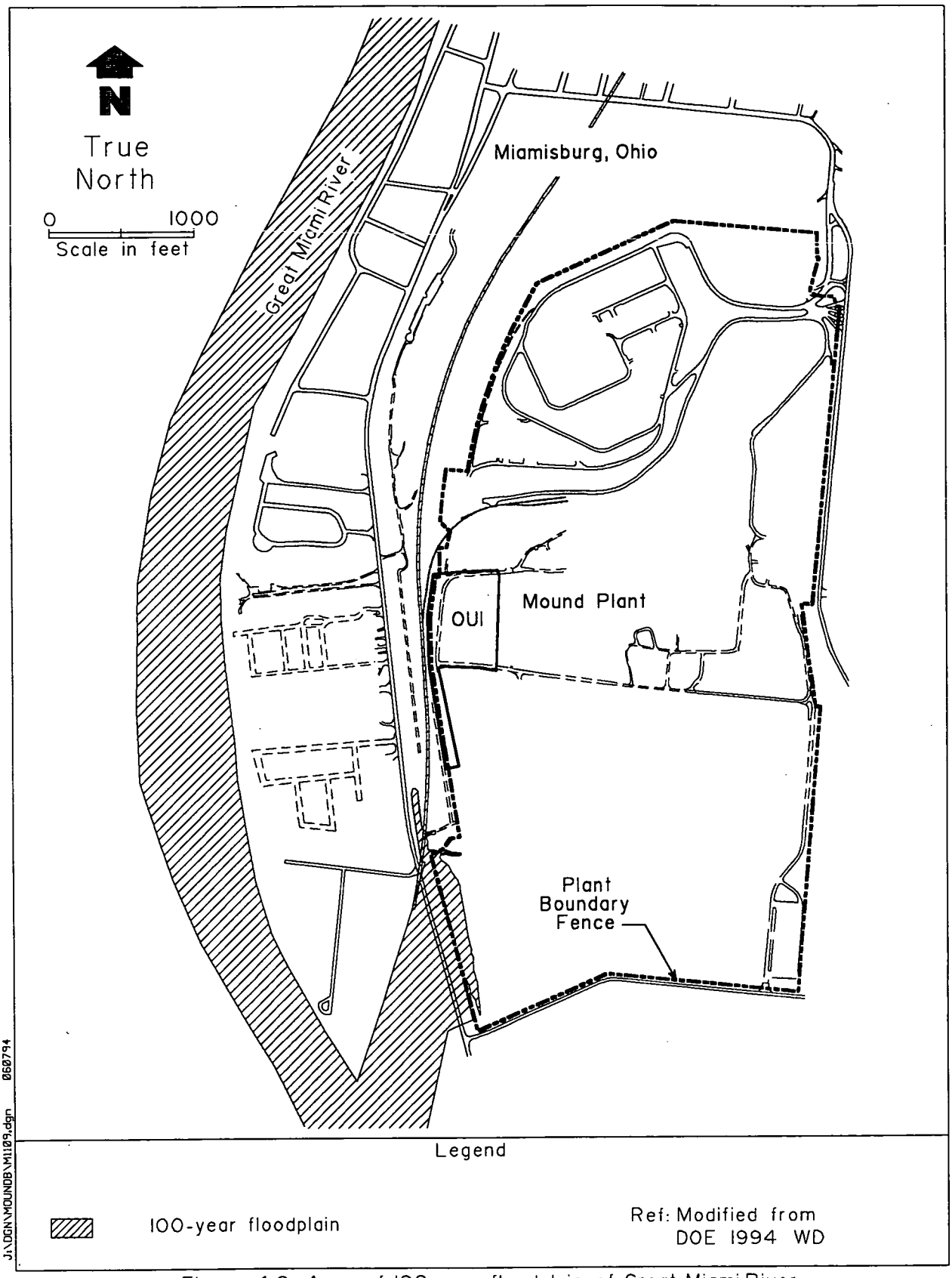


Figure 4.2. Area of 100-year floodplain of Great Miami River modified in letter of map amendment by FEMA.

plants growing in and adapted to an aquatic or very wet environment); consequently, the Overflow Pond is not designated as a wetland but as a waterway. The closest wetland to Operable Unit 1 is a sedimentation basin approximately 600 ft to the north (DOE 1994c).

None of the remedial action alternatives would involve conducting any activities in the Overflow Pond. Therefore, wetlands or waters of the United States would not be adversely affected.

4.11.3. Flora and Fauna

An ecological field assessment of the Mound Plant was performed in 1992 and 1993. This field assessment was designed to

- identify the flora and fauna at and around the Mound Plant,
- identify sensitive environments (e.g. wildlife breeding areas) at and around the Mound Plant, and
- identify threatened and endangered species and their habitats at and around the Mound Plant.

The results of the field assessment are presented in the Operable Unit 9, Ecological Characterization Report (DOE 1994d), and the results will be used with site contamination data to perform an ecological risk assessment.

As shown in Figure 4.3, Operable Unit 1 contains four habitat types. The Overflow Pond in Operable Unit 1 is a waterway, and the east and west sides of Operable Unit 1 are maintained lawns. Subxeric grasslands exist around the Overflow Pond on the east and south, and a small area of shrub/scrub habitat is located at the southern boundary of Operable Unit 1 (DOE 1994d). The plant community around the margin of the Overflow Pond is dominated by non-hydrophytic vegetation such as crown vetch, meadow fescue, and hairy-seed paspalum (DOE 1994c). The maintained lawns consist primarily of meadow fescue, Kentucky blue grass, Canada blue grass, and rough dropseed. The most conspicuous plants in the subxeric grasslands are meadow fescue, Kentucky blue grass, Canada blue grass, and rough dropseed. Herbs consist primarily of Canada goldenrod, spotted knapweed, Queen Anne's lace, and English plantain. The shrub/scrub habitat is dominated by Amur honeysuckle. Widely scattered small trees such as black locust may be present, and other woody species include frost grape, soft hawthorne, and boxelder. Meadow fescue and Kentucky blue grass are the most prevalent grasses (DOE 1994d).

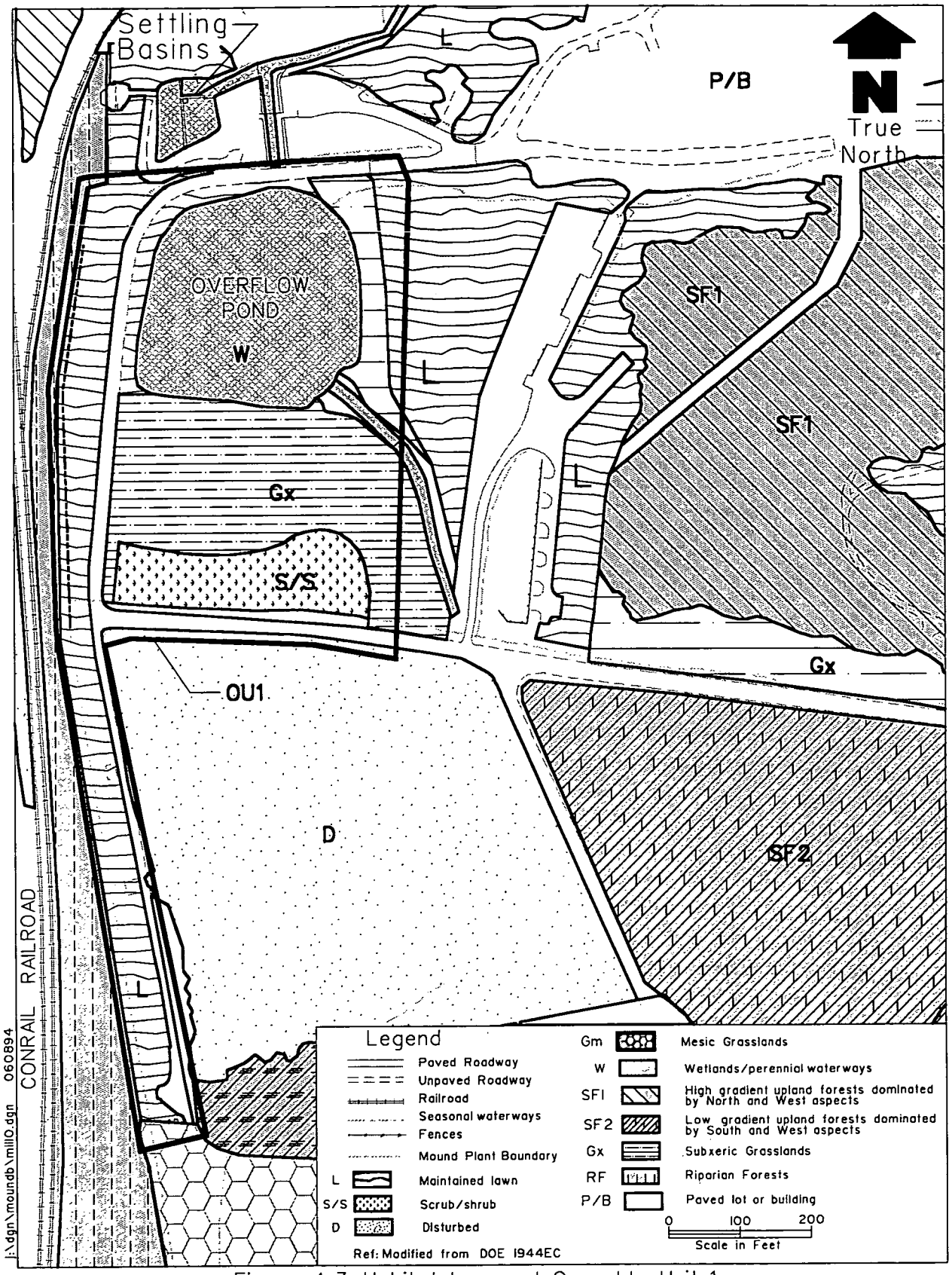


Figure 4.3. Habitat types at Operable Unit 1.

During the ecological field assessment, 81 species of birds were observed at the Mound Plant. Of these, 11 species were confirmed as nesting at the plant while 22 species were suspected of nesting there. All of the species known or suspected to nest at the plant are common species and are known to nest in the area surrounding the plant. The ten most common birds at the Mound Plant were the American robin, European starling, northern cardinal, American goldfinch, Carolina chickadee, house finch, mourning dove, red-winged blackbird, song sparrow, and common grackle. Five species of raptors were observed, with the American kestrel being the most common. Several game species were observed at or in proximity to the Mound Plant, and the mourning dove was one of the more common game species observed (DOE 1994d).

Seventeen mammals were observed at the Mound Plant. Small mammals included the short-tailed shrew, eastern chipmunk, deer mouse, white-footed mouse, meadow vole, house mouse, and meadow jumping mouse. Large mammals were the opossum, eastern cottontail, groundhog, gray squirrel, fox squirrel, gray fox, raccoon, striped skunk, white-tailed deer, and muskrat. Several of the large mammals are managed as game species including the white-tailed deer, eastern gray and eastern fox squirrels, woodchuck, and gray fox (DOE 1994d).

Ten species of reptiles and amphibians were identified at the Mound Plant. The most common reptile was the rat snake, and the most common amphibian was the red-backed salamander. Both of these species were found in a wide range of habitat types. The green sunfish was the only fish species identified at the Mound Plant, and a number were found in the Settling Basins and the Overflow Pond. The Settling Basins are immediately north of the Overflow Pond but outside Operable Unit 1 (Figure 4.3). No fish were found in the Asphalt Pond. In the spring, fish in the Settling Basins and Overflow Pond exhibited deformities, eroded fins, lesions, tumors, emaciation, and parasites, which could be associated with overcrowding in these ponds (DOE 1994d).

All of the remedial action alternatives except the no-action alternative would involve some amount of surface disturbance in Operable Unit 1. This surface disturbance could directly and indirectly affect flora and fauna. Direct effects could include the loss of plant communities, loss of less mobile wildlife species, and displacement of other wildlife species. The indirect effects would arise from increased fugitive dust, noise, and human activity. The magnitude and duration of the direct and indirect effects would depend on the magnitude and duration of the remedial action and on the restoration that would occur after the remedial action. No remedial action activities would be performed in the Overflow Pond; therefore, the flora and fauna associated with this waterway would not be affected.

Surface disturbance associated with remedial action for Operable Unit 1 could result in the loss of areas of maintained lawns, subxeric grasslands, and shrub/scrub plant communities. While these

habitats exhibit a high diversity of plant species, the areas that would be disturbed would be very small and would be restored to their original condition or as close to their original condition as possible. The disturbed areas would be graded to establish non-erosive drainage and revegetated with plant species common to the Mound Plant. Wildlife in the disturbed habitats could also be lost or temporarily displaced, but these effects would not be expected to be appreciable due to the small areas involved and the short duration of the surface disturbing activities. The maintained lawns and subxeric grasslands do not support large fauna populations. The shrub/scrub habitat supports a large number of bird species; however, the size of this habitat in Operable Unit 1 is small, and birds disturbed by the remedial action could easily relocate to nearby similar habitat. It was concluded in the ecological field assessment that the Mound Plant has diverse flora and fauna, but the habitat and species composition at the plant is neither unique or even of local importance (DOE 1994d).

The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, and the U.S. Fish and Wildlife Service were contacted about the presence of threatened and endangered species at the Mound Plant. These agencies suggested that the probability of threatened and endangered species occurring at the plant was very low. Despite this information, specialized habitats capable of harboring protected species (e.g., wetlands, seeps, springs, and riparian zones) were carefully scrutinized during field evaluations (DOE 1994d).

No federally listed, threatened, or endangered species were identified at the Mound Plant, and none are expected to be identified. Two state-protected species were found. Inland rush has been designated as endangered by the state, and a single individual of this grass species was discovered growing adjacent to a limestone seepage area in an open grassland on the South Property. Because only a single individual was found, inland rush cannot be considered as a viable breeding population at the Mound Plant, and the solitary occurrence should not interfere with ongoing or future activities at the plant. The dark-eyed junco is also designated as endangered by the state. Several individuals of this bird species were observed foraging in grassland, shrub/scrub, and forested habitats. This bird species is a common winter visitor to Ohio and much of the eastern United States, but only a small population is known to actually breed within the state. There are currently no known breeding populations of the dark-eyed junco in southern Ohio; the only known breeding populations occur in the extreme northeastern portion of Ohio (DOE 1994d). None of the remedial action alternatives would have any adverse effects on threatened and endangered species.

4.11.4. Cultural Resources

The only cultural resource site in the vicinity of the Mound Plant is an ancient Indian mound, the Miamisburg Mound, 380 ft east-southeast of the Plant. This mound is in the Miamisburg Mound State

Memorial Park (DOE 1979). A complete literature search and cultural resource survey of the Mound Plant and adjacent areas was performed in 1991. The literature search indicated that four houses circa 1875 and 1904-1905 and two crescent-shaped earthworks circa 1914 existed within the main plant property. The areas containing these houses and earthworks are now occupied by modern structures; consequently, none of the older structures nor remnants of them were found during the field survey. Four historic sites were found in areas adjacent to the Mound Plant. These sites consisted of a portion of the Miami-Erie Canal and associated features, a bridge, a bridge remnant, and a 1945 city water-well. These sites do not meet the requirements for inclusion in the National Register of Historic Places (Beamer 1991). None of the remedial action alternatives would have any adverse effects on cultural resources.

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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ACRONYMS

ACL	alternative concentration limits (CERCLA)
ARARs	applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
FS	feasibility study
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
OU	operable unit
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
TBC	to be considered

ARARs DISCUSSION

This document provides an analysis of the applicable or relevant and appropriate requirements (ARARs) for the feasibility study (FS) for Operable Unit 1 (OU 1). Although other such analyses have been performed at Mound Plant, this is the first such effort specific to OU 1. Accordingly, ARARs analysis in this document begins with an identification of potential standards for each type of ARAR (chemical-, location-, and action-specific), proceeds through a brief analysis of each standard, and, finally, presents a concluding summary of the apparent controlling ARARs for remedial actions in OU 1. This document describes the evolutionary process for each ARAR type as it applies to OU 1.

Section 1 of this appendix describes the overall ARARs basis and process. Sections 2, 3, and 4, respectively, describe the nature of chemical-, location-, and action-specific ARARs and describes the analysis process for these ARARs for OU 1. Included in each section are tables illustrating specific ARARs at various evolutionary stages. Because this is the first ARARs analysis for OU 1 and because of the extremely large number of standards to be evaluated, explanation of the evaluation of each standard is presented in the tables rather than in narrative form.

As an aside, based on a review of potential chemical-specific ARARs for OU 1, chemical-specific ARARs do not currently exist for soils. Soil contamination in OU 1 is not currently believed to be of concern; however, if this is later determined to be incorrect, cleanup objectives will be based on the calculated risk to human health and the environment.

1. THE ARAR BASIS

The basis for ARARs is cited in Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments Reauthorization Act (SARA), which requires that Fund-financed, enforcement, and federal facility remedial actions comply with all applicable or relevant and appropriate federal environmental or promulgated state environmental or facility siting laws. "For the purposes of identification and notification of promulgated state standards, the term ***promulgated*** means that the standards are of general applicability and are legally enforceable" [National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) 300.400(g)(4)].

"Applicable requirements," as defined in 40 CFR 300.5, are "those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA

site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable." "Relevant and appropriate requirements," also defined in 40 CFR 300.5, are "those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws, that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate." The most stringent promulgated standards are applied as ARAR (Preamble to NCP, 55 FR 8741, 8 March 1990).

1.1. TO BE CONSIDERED ARARS

In addition to ARARs, advisories, criteria, or guidance may be identified "to be considered" (TBC) for a particular release. As defined in 40 CFR 300.400(g)(3), the TBC category "consists of advisories, criteria, or guidance developed by the U.S. Environmental Protection Agency, other federal agencies, or states that may be useful in developing CERCLA remedies." Use of TBCs is discretionary rather than mandatory, as opposed to the use of ARARs, which is mandatory.

1.2. ARAR CATEGORIES

In general, there are three categories of ARARs:

- Ambient or chemical-specific requirements.
- Location-specific requirements.
- Performance, design, or other action-specific requirements.

ARARs are generally considered to be dynamic in nature in that they evolve from general to very specific in the CERCLA site clean-up process. Initially during the remedial investigation (RI) work plan stage, probable chemical-specific ARARs may be identified, usually based on a limited amount of data. Chemical-specific ARARs at this point have meaning only in that they may be used to establish appropriate detection limits so that data collected in the RI will be amenable for comparison to ARAR standards. Identified potential chemical-specific ARARs may be modified if they are found to be inappropriate any time in the RI process. For example, chemical-specific ARARs could be deleted based on the absence of a constituent in analytical data obtained during the investigation.

Location-specific ARARs specify restrictions that have been placed on the concentration of hazardous substances or on the conduct of an activity solely because it occurs in a special location. As discussed in Section 2, information relevant to the location-specific ARARs analysis has been gathered for Mound Plant as a whole by the Environmental Restoration Program.

Action-specific ARARs and remediation goals are identified as the FS process continues. Initially, programs with standards that could apply to any of a large list of alternatives are identified. As the specific alternatives that are to be evaluated in the FS process are developed, the ARARs list is narrowed. At the end of the FS process, items are identified that are ARAR to only the alternatives selected for detailed evaluation.

1.3. FEASIBILITY STUDY ARAR REQUIREMENTS

Development of a preliminary list of potential chemical-specific ARARs allows the establishment of a list of preliminary remediation goals in the FS process, which is essentially a tentative listing of contaminants together with initially anticipated clean-up concentrations or risk levels for each medium. Preliminary remediation goals serve to focus the development of alternatives on remedial technologies that can achieve the remediation goals, thereby limiting the number of alternatives to be considered in the detailed remedial alternative analysis, conducted later in the FS process. As more information becomes available from risk assessment activity, remediation goals are refined and clarify the objectives remedial alternatives will be expected to attain.

At the beginning of the FS process, a preliminary consideration of action-specific ARARs is commonly conducted. As remedial alternatives are screened during the FS, action-specific ARARs are identified. When the detailed analysis of the remedial alternatives is conducted, all action-specific ARARs are refined to a much more detailed form with respect to each alternative before a comparison of alternatives begins. At this point, a discussion is provided in the FS report for each remedial alternative regarding the rationale for all ARAR determinations. Specific action-specific ARAR compliance is planned after the FS process is completed and once the final alternative is selected and designed.

2. REMEDIAL ACTION AND REMEDIATION GOALS

CERCLA §121 specifically requires attainment of all ARARs. Moreover, as explained in the preamble to the NCP (55 FR 8741), in order to attain all ARARs a remedial action must comply with the most stringent requirement, which then ensures attainment of all other ARARs. Furthermore, CERCLA requires that the remedies selected must attain ARARs and be protective of human health and the environment. Consequently, preliminary remediation goals based on ARARs require modification as

new information and data are collected in the RI, including the baseline risk assessment, or when ARARs are not available or are determined to be inadequate for protection of human health and the environment.

Development of remediation goals is actually a portion of the overall development of remedial action objectives, which ultimately will define the required endpoint of the selected remedial action. As stated in the preamble to the NCP (55 FR 8712-8713), "remedial action objectives are the more general description of what the remedial action will accomplish. Remediation goals are a subset of remedial action objectives and consist of medium-specific or operable unit-specific chemical concentrations that are protective of human health and the environment and serve as goals for the remedial action. The remedial action objectives ... should specify: (1) the contaminants of concern, (2) the exposure routes and receptors, and (3) an acceptable contaminant level or range of levels for each exposure medium (i.e., a preliminary remediation goal)." Remediation goals will establish acceptable exposure levels, per 40 CFR 300.430 (e)(2)(i), which are protective of human health and the environment and will be developed by considering the following:

- ARARs (chemical-specific)
  - Acceptable exposure levels for systemic toxicants.
  - Acceptable exposure levels for known or suspected carcinogens (10^{-6} to 10^{-4} risk levels).
  - Technical limitations (e.g., detection limits).
  - Uncertainty factors.
  - Other pertinent information.

- Maximum Contaminant Level Goals (MCLGs) (or MCLs where MCLGs are zero) where relevant and appropriate.

- Acceptable exposure levels where multiple contaminants or multiple exposure pathways will cause exposure at ARAR levels resulting in cumulative risk in excess of 10^{-4}.

- Clean Water Act (CWA) ambient water quality criteria, where relevant and appropriate.

- A CERCLA Alternative Concentration Limit (ACL) established pursuant to CERCLA § 121(d)(2)(B)(ii).

- Environmental evaluations shall be performed to assess threat to the environment, especially sensitive habitats and critical habitat of species protected under the Endangered Species Act.

Once a preferred remedial action alternative is formally selected, all chemical-, location-, and action-specific ARARs have also been defined. If it is found that the most suitable remedial alternative does

not meet an ARAR, the NCP provides for waivers of ARARs under certain circumstances. According to 40 CFR 300.430(f)(1)(ii)(C),

> *An alternative that does not meet an ARAR under federal environmental or state environmental or facility siting laws may be selected under the following circumstances:*
>
> > *(1) The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement;*
> >
> > *(2) Compliance with the requirement will result in greater risk to human health and the environment than other alternatives;*
> >
> > > *(3) Compliance with the requirement is technically impracticable from an engineering perspective;*
> >
> > *(4) The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach;*
> >
> > *(5) With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state; or*
> >
> > *(6) For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites may present a threat to human health and the environment.*

Accordingly, if any of the alternatives selected for OU 1 are not expected to attain any ARARs, this expectation must be expressed together with an appropriate justification that relates to at least one of the ARAR waiver circumstances identified above.

From this point, the alternative will become the final remedy as it is incorporated into the ROD. Once the final Record of Decision (ROD) has been signed, requirements must be modified only when they are determined to be applicable or relevant and appropriate <u>and</u> necessary to ensure that the remedy is protective of human health and the environment [40 CFR 300.430(f)(1)].

2.1. CHEMICAL-SPECIFIC ARARS

Health-based, chemical-specific ARARs pertinent to groundwater (the environmental medium addressed by this document) have been identified for the volatile and semivolatile organic compounds, metals,

other anions, pesticides, as well as radionuclides that were detected in groundwater. These compounds are used as the contaminants of concern for the purposes of this ARARs document.

The chemical-specific ARARs are primarily derived from federal and state health and environmental statutes and regulations. As discussed below, in some instances these standards are classified as items "to be considered." A summary of the universe of potential chemical-specific ARARs for the contaminants found at OU 1 in the groundwater is presented in Tables 1 and 2. Table 1 presents the potential Ohio chemical-specific ARARs and includes determinations relative to whether these standards should be considered ARAR. Similarly, Table 2 presents the potential federal chemical-specific ARARs and determinations.

Table 3 presents the numeric standards derived from the requirements identified as ARARs in Tables 1 and 2. Maximum concentrations for each contaminant of concern identified in the OU 1 groundwater are shown in the table for comparison to the ARARs.

Finally, Table 4 presents a summary of proposed controlling ARARs based on a selection of the most stringent ARARs from Table 3. It will be these ARARs, with some modification as a result of background determinations, that will be used along with risk-based concentrations to establish cleanup goals for OU 1 remediations.

2.2. LOCATION-SPECIFIC ARARS

Location-specific ARARs are statutes or regulations which set restrictions on activities or limits on contaminant levels solely because of location, e.g., within a floodplain, wetland, historic place, or sensitive ecosystem or habitat. Examples of locational requirements are federal and state siting laws for hazardous waste facilities (floodplain restrictions), and federal regulations to avoid adverse effects to wetlands (40 CFR Part 230, 33 CFR Parts 320-330, and 40 CFR Part 6, Appendix A). Also included are the floodplain regulations promulgated pursuant to the federal Emergency Management Agency National Flood Insurance Program. The range of potential location-specific requirements considered in this detailed analysis of alternatives for state and federal requirements are presented in Tables 5 and 6. As was the case with the chemical-specific ARARs, these tables also include a determination of whether each requirement should be considered ARAR.

2.3. ACTION-SPECIFIC ARARS

Performance, design, and other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements

are not triggered by the specific chemicals present at a site, but rather by site characterization activities and remedial actions that are conducted or proposed during the RI/FS. Potential action-specific ARARs are technology-based performance standards, such as the Best Available Technology standard of the Federal Water Pollution Control Act. Other examples include Resource Conservation and Recovery Act (RCRA) treatment, storage, and disposal standards, and CWA pre-treatment standards for discharges to publicly-owned treatment works. The range of potential action-specific requirements considered in this document are presented in Tables 7 and 8. Determinations of whether each standard should be considered ARAR are included in both tables and are based on a tentative identification of the alternatives that will be presented in the FS report. These alternatives are described in the following text.

1. ***No Action.*** This alternative (required by the NCP) will be found not applicable because institutional controls are already in-place at Mound Plant as well as groundwater monitoring.

2. ***Institutional Controls.*** This alternative has already been used at Mound Plant and will be used in conjunction with other alternatives.

As a matter of practicality, institutional controls, long-term monitoring, and drainage controls (sealing surface drainage ditches) will be a part of all subsequent alternatives.

3. **Collection/Disposal.** This alternative will feature recovery wells as a means of capturing contaminated groundwater. The collected groundwater would be discharged through the National Pollutant Discharge Elimination System (NPDES) outfall if concentrations of contaminants are below required limits. NPDES permit revisions may be required to implement this disposal.

4. ***Collection/Treatment Disposal.*** This alternative consists of recovery wells for capturing contaminated groundwater as in Alternative #3. The collected groundwater would be treated before discharge through a NPDES outfall so that concentrations of contaminants would be below required limits. As may be seen from Table 9, NPDES permit revisions may be required to implement this disposal.

5. ***Surface Cap/Collection/Treatment/Disposal.*** This alternative consists of the elements of Alternative #3, an extended surface cap, plus treatment of the collected groundwater to allow disposal through the NPDES outfall.

6. ***Containment/Collection/Treatment/Disposal.*** This alternative will consist of a containment system comprised of a slurry wall or interceptor trench with an impermeable downgradient face on the trench. The upgradient (eastern) side of the site may require a cutoff wall of some kind, as well, in order to prevent continued groundwater movement into the area. Collection, treatment, and disposal would consist of the elements discribed in Alternative 3.

7. *Surface Cap/**Containment/Collection/Treatment/Disposal.*** This alternative would combine the elements of Alternative #5 with an extended surface cap.

8. ***In situ Treatment.*** This alternative could consist of a slurry wall/treatment wall wherein some sort of funnel and gate system would direct contaminated groundwater through an emplaced reactive material that would effectively treat the groundwater without removing it from the ground.

9. **Surface Cap/In situ Treatmnet.** This alternative consists of the elements described for Alternative #8 with the addition of an extended surface cap.

As part of implementing the selected alternative, it is possible that some contaminants or disposed materials may be exhumed; "generated" from a regulatory perspective. Such materials will be evaluated through a combination of analysis and knowledge of the materials disposed in the area and will be characterized as solid and potentially hazardous waste, as appropriate. Where available, the process that generates the waste disposed of in Area B will be used to the extent possible to determine if any of the waste should be considered listed hazardous waste, as defined in 40 CFR 261 Subpart D and OAC 3745-51-20 to 33. Analysis of these materials will include, at a minimum, testing for hazardous waste characteristics; ignitability, corrosivity, reactivity, and toxicity (see Table 10). Proper management/disposal standards will be established based on the results of this characterization.

Table 1. Potential State Chemical-Specific ARARs

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Prohibits Violation of Air Pollution Control Rules/3704.05 A-I	Prohibits emission of an air contaminant in violation of Sec. 3704 or any rules, permit, order or variance issued pursuant to that section of the ORC.	May pertain to any site where emissions of an air contaminant occur either as a preexisting condition of the site or as a result of remedial activities. Should be considered for virtually all sites.	Not ARAR	This is effectively a provision that gives Ohio EPA the authority to enforce state air regulations and permits. Implementation of the substantive provisions of state air requirements as ARARs is required by Section 121(d) of CERCLA.
"Five Freedoms" for Surface Water/ 3745-1-04 A,B,C,D,E	All surface waters of the state shall be free from: A) Objectionable suspended solids. B) Floating debris, oil, and scum. C) Materials that create a nuisance. D) Toxic, harmful, or lethal substances. E) Nutrients that create nuisance growth.	Pertains to both discharges to surface waters as a result of remediation and any onsite surface waters affected by site conditions.	Not ARAR	Surface water bodies subject to quality criteria standards do not occur within Operable Unit 1. Alternatives that involve discharge to surface water will be addressed in action-specific ARARs
Antidegradation Policy for Surface Water/ 3745-1-05 A,B,C	Prevents degradation of surface water quality below designated use or existing water quality. Existing instream uses shall be maintained and protected. The most stringent controls for treatment shall be required by the Director of the EPA for all new and existing point source discharges. Prevents any degradation of "State Resource Waters."	Pertains to both discharges to surface water as a result of remedial action and any surface water affected by site conditions.	Not ARAR	Surface water bodies subject to quality criteria standards do not occur within Operable Unit 1. Alternatives that involve discharge to surface water will be addressed in action-specific ARARs discussion.
Water Quality Criteria/ 3745-1-07 C	Establishes water quality criteria for pollutants that do not have specific numerical or narrative criteria identified in Tables 7-1 through 7-15 of this rule.	Pertains to both discharges to surface waters as a result of remedial action and any surface waters affected by site conditions.	Not ARAR	Surface water bodies subject to quality criteria standards do not occur within Operable Unit 1. Alternatives that involve discharge to surface water will be addressed in action-specific ARARs discussion.
Ground Water Protection: Applicability/ 3745-54-90	Establishes circumstances under which an operator of a hazardous waste facility must implement a groundwater protection program or a corrective action program.	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills), including existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
3745-54-91(A)-(B)				

Table 1. (page 2 of 6)

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Required Programs/ 3745-54-91 (A)-(B)	Establishes requirements for conducting a groundwater compliance monitoring and response program.	Whenever hazardous constituents from a regulated unit are detected at the compliance point, or whenever groundwater protection standards are exceeded between the compliance point and the downgradient facility property boundary.	ARAR	Exceedences of groundwater protection standards have been observed within OU-1. Groundwater monitoring program is ongoing and a program will be implemented as part of a remedial alternative which will follow requirements of this ARAR.
Ground Water Protection Standard: Hazardous Waste Facilities/3745-54-92	Compliance must be attained with the conditions specified in the permit to ensure that hazardous constituents (see 3745-54-93) do not exceed the promulgated limits (see 3745-54-94).	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills), including existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
Hazardous Constituents in Ground Water: Hazardous Waste Facilities/3745-54-93 A,B	Requires that permit specify hazardous constituents to which the groundwater protection standard of 3745-54-92 applies. Hazardous constituents are constituents identified in the appendix of this rule, which have been detected in groundwater in the uppermost aquifer underlying the unit(s) and are reasonably expected to be in or derived from waste contained in the unit(s).	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills), including existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
Concentration Limits for Ground Water: Hazardous Waste Facilities/3745-54-94 A,B	Presents the methodology for determining concentration limits and alternative concentration limits.	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills), including existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
Point of Compliance for Ground Water: Hazardous Waste Facilities/3745-54-95 A,B	Establishes point of compliance at vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the unit(s).	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills), including existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.

Table 1. (page 3 of 6)

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Compliance Period for Ground Water: Hazardous Waste Facilities/3745-54-96 A,B,C	A compliance period during which groundwater protection standards will be specified in the permit. Rule requires that the compliance period for a facility undergoing a corrective action program will be extended until it can be demonstrated that the groundwater protection standard of OAC 3745-54-92 have not been exceeded for a period of 3 consecutive years.	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills), including existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
General Ground Water Monitoring Requirements: Hazardous Waste Facilities/3745-54-97 A-J	Presents general groundwater monitoring program requirements, including number, location, and depth of wells; casing requirements; sampling and analysis procedures; etc.	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills), including existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
Ground Water Detection Monitoring Program: Hazardous Waste Facilities/ 3745-54-98 A-H	Presents requirements of groundwater detection program.	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills) at which hazardous constituents have not been detected in the ground water. This includes existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
Ground Water Compliance Monitoring Program: Hazardous Waste Facilities/ 3745-54-99 A-J	Presents requirements of groundwater compliance monitoring program.	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills) at which hazardous constituents have not been detected. This includes existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.
Ground Water Corrective Action Program: Hazardous Waste Facilities/ 3745-55-01 A-H	Presents the requirements of a groundwater corrective action program that prevents hazardous constituents from exceeding their respective concentration limits at the compliance point by either removing or treating these hazardous constituents.	Pertains to all sites with land-based hazardous waste units (surface impoundments, waste piles, land treatment units, and landfills) at which hazardous constituents have been detected. This includes existing land-based areas of contamination.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Groundwater monitoring implemented as part of the remedial alternatives will incorporate the requirements of the hazardous waste regulations.

Table 1. (page 4 of 6)

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Recordkeeping and reporting/3745-55-02	Establishes recordkeeping and reporting requirements for all types of hydrogeologic and water quality data.	Pertains to all hazardous waste disposal facilities, waste piles, and surface impoundments.	ARAR	All ongoing or proposed groundwater monitoring activities will follow requirements of this ARAR.
Maximum Contaminant Levels for Inorganic Chemicals/3745-81-11 A,B	Presents maximum contaminant levels for inorganics.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Because of the potential impacts to the Buried Valley Aquifer, this standard will be applied.
Maximum Contaminant Levels for Organic Chemicals/3745-81-12 A,B,C	Presents maximum contaminant levels for organics.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Because of the potential impacts to the Buried Valley Aquifer, this standard will be applied.
Maximum Contaminant Levels for Turbidity/ 3745-81-13 A,B	Presents maximum contaminant levels for turbidity.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Because of the potential impacts to the Buried Valley Aquifer, this standard will be applied.
Maximum Microbiological Contaminant Levels/ 3745-81-14 A	Presents maximum contaminant levels for microbiological contaminants.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Because of the potential impacts to the Buried Valley Aquifer, this standard will be applied.
Maximum Contaminant Levels for Radium-226, -228, and Gross Alphas/3745-81-15 A,B	Presents maximum contaminant levels for radium-226, radium-228, and gross alpha particle activity.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Because of the potential impacts to the Buried Valley Aquifer, this standard will be applied.
Maximum Contaminant Levels for Beta Particle and Photon Radioactivity/ 3745-81-16 A,B	Presents maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Because of the potential impacts to the Buried Valley Aquifer, this standard will be applied.

Table 1. (page 5 of 6)

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Microbiological Contaminant Sampling and Analytical Requirements/ 3745-81-21 A	Presents sampling and analytical requirements for microbiological contaminants.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Appropriate methods for monitoring compliance with ARARs will be coordinated with Ohio EPA and U.S. EPA.
Turbidity Contaminant Sampling and Analytical Requirements/ 3745-81-22 A	Presents sampling and analytical requirements for turbidity.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Appropriate methods for monitoring compliance with ARARs will be coordinated with Ohio EPA and U.S. EPA.
Inorganic Contaminant Monitoring Requirements/ 3745-81-23 A	Presents monitoring requirements for inorganic contaminants.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Appropriate methods for monitoring compliance with ARARs will be coordinated with Ohio EPA and U.S. EPA.
Organic Contaminant Monitoring Requirements/ 3745-81-24 A-E	Presents monitoring requirements for organic contaminants.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Appropriate methods for monitoring compliance with ARARs will be coordinated with Ohio EPA and U.S. EPA.
Analytical Methods for Radioactivity/ 3745-81-25 A-D	Presents analytical methods for radioactivity.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Appropriate methods for monitoring compliance with ARARs will be coordinated with Ohio EPA and U.S. EPA.
Monitoring Frequency for Radioactivity/ 3745-81-26 A,B	Present monitoring requirements for radioactivity.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Appropriate methods for monitoring compliance with ARARs will be coordinated with Ohio EPA and U.S. EPA.

Table 1. (page 6 of 6)

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Analytical Techniques/ 3745-81-27 A,B,C	Presents general analytical techniques for maximum contaminant levels.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	ARAR	Appropriate methods for monitoring compliance with ARARs will be coordinated with Ohio EPA and U.S. EPA.
Requirements for a Variance from Maximum Contaminant Levels/3745-81-40 A,B,C	Provides criteria by which Director of the Ohio EPA may grant variance from maximum contaminant levels.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	Not ARAR	Variances from ARARs, as appropriate, will be accomplished according to the procedures established by CERCLA.
Alternative Treatment Technique Variance/ 3745-81-46	Allows for the use of alternative treatment techniques to attain maximum contaminant levels.	Pertains to any site that has contaminated surface or groundwater that is either being used or has the potential for use as a drinking water source.	Not ARAR	Variances from ARARs, as appropriate, will be accomplished according to the procedures established by CERCLA.

Table 2. Potential Federal Chemical-Specific ARARs for Mound Plant

Regulatory Program	Requirement	ARAR	Comment
Clean Water Act (CWA)	Acute CWA freshwater toxicity criterion (CWA §304) Chronic CWA freshwater toxicity criterion (CWA §304) EPA ambient water quality criteria (WQC) for protection of human health aquatic organisms, and drinking water standards (CWA §304) EPA ambient water quality criteria(WQC) for protection of human health aquatic organisms only (CWA §304)	ARAR	Compliance is specifically required by CERCLA §121(d) where relevant and appropriate. Will be applied except where more appropriate standards exist. For example, standards specifically intended for groundwater or drinking.
Safe Drinking Water Act (SDWA)	MCLs (40 CFR .11 to 141.16) MCLGs (40 CFR § 141.50)	ARAR	Compliance is specifically required by CERCLA §121(d) where relevant and appropriate.
Resource Conservation and Recovery Act (RCRA) Groundwater Monitoring Requirements	Groundwater Protection Program for Hazardous Waste "Regulated Units" (40 CFR 264 Subpart F)	ARAR	Considered relevant and appropriate because of historic disposal of apparent hazardous wastes.

Table 3. Parameters Detected at Operable Unit 1 and Associated Regulatory Guidelines

Analyte	Maximum Detected Value[a]	Location	Log Date	Estimated Quantitation Limits	SDWA MCLG	SDWA MCL	RCRA 40 CFR 264 Subpart F	Ohio Drinking Water Rule	CWA Freshwater Toxicity Criterion (Acute)	CWA Freshwater Toxicity Criterion (Chronic)	CWA Human Health Standards Published Criteria	
											Water and Organism	Organism Only
Inorganic (Total Metals)	µg/L			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	115000	0313	08/04/91	200	–	–	–	–	[b]	[b]	[b]	[b]
Antimony	415	0313	08/04/91	60	6	6	60[f]	–	–	–	146	45,000
Arsenic	16.9	0313	12/17/91	10	–	50	50[f]	50	(iii) 360/ (v) 850[d]	(iii) 190	0.0022	0.0175
Barium	1640	0313	08/04/91	200	2,000	2,000	1,000[f]	1,000	–	–	1,000	–
Beryllium	11.1J	0313	08/04/91	5	4	4	5[f]	–	130[d]	5.3[d]	.0037	0.0641
Cadmium	53.5J	0313	08/04/91	5	5	5	10[f]	10	3.9[c]	1.1[c]	10	–
Calcium	1180000J	0313	12/17/91	5,000	–	–	–	–	–	–	–	–
Chromium (total)	2900	0313	12/17/91	10	100	100	50[f]	50	(iii) 1,700	210[d]	170,000	3,433,000
									(vi) 16	11	50	–
Cobalt	266J	0313	08/04/91	50	–	–	50[h]	–	–	–	–	–
Copper	449J	0313	08/04/91	25	1,300	–	25[g]	–	18[d]	12[d]	–	–
Iron	407000	0313	08/04/91	100	–	–	–	–	–	1,000	300	–
Lead	126	0313	12/17/91	5	0	–	50[f]	50	82[d]	3.2[d]	50	–
Magnesium	858000	0313	08/04/91	5,000	–	–	–	–	–	–	–	–
Manganese	15500	0313	08/04/91	15	200	–	–	–	–	–	50	100
Mercury (inorganic)	0.42	0313	08/04/91	2	2	2	2[f]	2	2.4	0.012	0.144	0.146
Nickel	1820	0313	08/04/91	40	100	100	40[f]	–	1,400[c]	160[c]	13.4	100
Potassium	30700	0380	03/31/93	5,000	–	–	–	–	–	–	–	–
Selenium	3.20J	0313	06/21/92	5	50	50	10[f]	10	20	5.0	10	–
Silver	147J	0313	08/04/91	10	–	–	10[f]	50	4.1[d]	0.12	–	50
Sodium	648000	0380	03/31/93	5,000	–	–	–	–	–	–	–	–
Thallium	68.0J	0313	03/22/92	10	.5	2	10[f]	–	1,400[d]	40[d]	13	48
Vanadium	393J	0313	08/04/91	10	–	–	10[g]	–	–	–	–	–
Zinc	991	0063	05/06/91	20	–	–	20[g]	–	120[d]	110[d]	–	–

Table 3. (page 2 of 3)

Analyte	Maximum Detected Value[k]	Location	Log Date	Estimated Quantitation Limits	SDWA MCLG	SDWA MCL	RCRA 40 CFR 264 Subpart F	Ohio Drinking Water Rule	CWA Freshwater Toxicity Criterion (Acute)	CWA Freshwater Toxicity Criterion (Chronic)	CWA Human Health Standards Published Criteria	
											Water and Organism	Organism Only
Miscellaneous Ions	(mg/L)											
Chloride	873	0123	06/16/92	0.001	–	–	–	–	860,000	230,000	–	–
Nitrate	3.59	0071	12/16/91	0.0002	10,000	10,000	–	10	–	–	10,000	–
Nitrate Nitrite	4.0	0152	03/20/92	0.0002	10,000	10,000	–	–	–	–	–	–
Sulfate	301J	0381	04/01/93	0.005	–	–	–	–	–	–	–	–
Volatiles	µg/L			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,2-*cis*-Dichloroethene	640J	0370	03/31/93	1.0	70	70	–	–	–	–	–	–
1,1-Dichloroethene	1.7J	0076	02/01/91	1.3	7	7	1.3[f]	7	–	–	0.033	1.85
1,2-Dichloroethene	38J	0154	05/04/91	1.0	70e	70e	1.0[f]	–	–	–	–	–
1,1,2,2-Tetrachloroethane	0.6J	0126	02/05/91	0.3	–	–	.3[f]	–	–	2,400[d]	0.17	10.7
1,1,1-Trichloroethane	18J	0378	03/28/93	0.3	200	200	.3[g]	200	18,000[d,h]	–	18,400	1,030,000
1,2-*trans*-Dichloroethene	6.5	0155	12/31/91	1.0	100	100	1.0[g]	–	–	–	–	–
1,1,2-Trichloro-1,2,2-Trifluoroethane	8.7J	0076	06/16/93	2.0	–	–	–	–	–	–	–	–
Benzene	3.0[e]	0313	09/17/92	2.0	0	5	2.0[g]	5	5,300[d]	–	0.66	40
Chloroethene	4.5	0370	03/31/93	1.0	0	2	1.0[g]	2	–	–	2	525
Dibromomethane	.20[e]	0063	06/22/91	2.0	0	0	2.0[g]	–	–	–	–	–
Dichloromethane-Methylene Chloride	13J	0313	10/31/90	5.0	0	5	5.0[g]	–	–	–	–	–
Tetrachloroethene	270J	0370	03/31/93	0.3	0	5	.3[g]	–	5,280[d]	840[d]	0.8	8.85
Tetrachloromethane	4.6	0370	03/31/93	1.2	0	5	1.2[g]	5	35,200[d]	–	0.4	6.94
Trichloroethene	210J	0370	03/31/93	1.2	0	5	1.2[g]	5	45,000[d]	21,900[d]	2.7	80.7
Trichlorofluoromethane	12	0370	03/31/93	2.0	–	–	2.0[g]	–	–	–	–	–
Trichloromethane	130J	0370	03/31/93	0.5	0	100	.5[g]	100	28,900[d]	1,240[d]	0.19	15.7
Semi-Volatiles	µg/L			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Bis(2-Ethylhexyl)Phthalate	3J	0129	03/17/92	10	–	–	10[g]	–	2,100[d]	160[d]	15,000	50,000
Butylbenzylphthalate	1J	0071	06/23/92	10	–	–	10[g]	–	–	–	–	–
Diethylphthalate	0.9J	0313	06/21/92	10	–	–	10[g]	–	–	–	350,000	1,800,000
Pyrene	0.7J	0063	09/16/92	10	–	–	10[g]	–	–	–	–	–

Table 3. (page 3 of 3)

Analyte	Maximum Detected Value[k]	Location	Log Date	Estimated Quantitation Limits	SDWA MCLG	SDWA MCL	RCRA 40 CFR 264 Subpart F	Ohio Drinking Water Rule	CWA Freshwater Toxicity Criterion (Acute)	CWA Freshwater Toxicity Criterion (Chronic)	CWA Human Health Standards Published Criteria	
											Water and Organism	Organism Only
Pesticides	µg/L			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
beta-BHC	.044	0129	03/17/92	50	–	–	50[g]	–	100[j]	–	–	–
alpha-Chlordane	0.070	0374	04/01/93	50	0	2	50[g]	–	2.4[i]	0.0043[i]	0.00046[i]	0.00048[i]
Endosulfan Sulfate	0.12J	0372	03/30/93	100	–	–	100[g]	–	–	–	–	–
Heptachlor	0.11[e]	0126	06/16/92	50	0	.4	50[g]	–	0.52	0.0038	0.00028	0.00029
Radionuclides	(pCi/L)			MDL (pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)
Actinium-227	1.6[e]	0071	02/01/91	~1.0	–	–	–	–	–	–	–	–
Potassium-40	170[e]	0313	02/03/91	20	0	–	–	–	–	–	–	–
Radium-226	1.72[e]	0313	08/04/91	1.0	0	–	–	5	–	–	–	–
Thorium-228	4.7[e]	0313	02/03/91	1.0	–	–	–	–	–	–	–	–
Thorium-230	1.5[e]	0271	02/01/91	1.0	–	–	–	–	–	–	–	–
Tritium	13800[e]	0310	10/30/90	500	0	20,000	–	20,000	–	–	–	–
Uranium-234	13[e]	0313	02/03/91	1.0	–	–	–	–	–	–	–	–
Uranium-235	4.7[e]	0313	02/03/91	1.0	–	–	–	–	–	–	–	–
Uranium-238	4.3[e]	0313	02/03/91	1.0	–	–	–	–	–	–	–	–

[e]Maximum value = Lab value; no validated value available.
[b]Criteria are pH dependent - see document.
[c]Hardness dependent criteria (400 mg/L $CuCO_3$ used).
[d]Insufficient data to develop criteria. Values present are the lowest observed effect level.
[e]Lower value of 1,2 *cis*-dichloroethene and 1,2-*trans*-dichloroethene.
[f]40 CFR 261 Appendix VIII constituent
[g]40 CFR 264 Appendix IX constituent
[h]Criterion is for total trichlorinated ethanes.
[i]Criterion is for chlordane.
[j]Criterion is for BHC.
[k]Values were extracted from the Mound Plant analytical database stored on WESTON computer system in Albuquerque, NM. These values are the highest concentrations regardless of source or sampling event.

Table 4. Parameters Detected at Mound Operable Unit 1 with Most Stringent Potential ARAR and Regulatory Citation

Analyte	Maximum Detected Value[1]	Location	Log Date	Estimated Quantitation Limits[1] (ug/L)	Most Stringent Potential ARAR	Associated Regulation
Inorganic (Total Metals)	(ug/L)					
Aluminum	115000	0313	08/04/91	200	–	
Antimony	415	0313	08/04/91	60	6	SDWA MCLG, 40 CFR Part 141
Arsenic	16.9	0313	12/17/91	10	50	SDWA MCL, 40 CFR Part 141
Barium	1640	0313	08/04/91	200	1000	Ohio Drinking Water Rule, O.A.C. 3745-81
Beryllium	11.1J	0313	08/04/91	5	4	SDWA MCLG, 40 CFR Part 141
Cadmium	53.5J	0313	08/04/91	5	5	SDWA MCLG, 40 CFR Part 141
Calcium	1180000J	0313	12/17/91	5,000	–	
Chromium (total)	2900	0313	12/17/91	10	50	Ohio Drinking Water Rule, O.A.C. 3745-81
					50	RCRA 40 CFR 264
Cobalt	266J	0313	08/04/91	50	50	RCRA 40 CFR 264
Copper	449J	0313	08/04/91	25	25	RCRA 40 CFR 264
Iron	407000	0313	08/04/91	100	300	CWA Human Health Standards
Lead (at tap)	126	0313	12/17/91	5	50	RCRA 40 CFR 264
Magnesium	858000	0313	08/04/91	5,000	–	
Manganese	15500	0313	08/04/91	15	200	SDWA MCLG, 40 CFR Part 141
Mercury (inorganic)	0.42	0313	08/04/91	.2	2	SDWA MCLG, 40 CFR Part 141
Nickel	1820	0313	08/04/91	40	40	RCRA 40 CFR 264
Potassium	30700	0380	03/31/93	5,000	–	
Selenium	3.20J	0313	06/21/92	5	10	RCRA 40 CFR 264
Silver	147J	0313	08/04/91	10	50	RCRA 40 CFR 264
Sodium	648000	0380	03/31/93	5,000	–	
Thallium	68.0J	0313	03/22/92	10	5	SDWA MCLG
Vanadium	393J	0313	08/04/91	10	10	RCRA 40 CFR 264
Zinc	991	0063	05/06/91	20	20	RCRA 40 CFR 264
Miscellaneous Ions	(mg/L)					
Chloride	873	0123	06/16/92	0.001	860,000	CWA Freshwater Toxicity Criterion; Clean Water Act §304
Nitrate	3.59	0071	12/16/91	0.0002	10,000	SDWA MCLG, 40 CFR Part 141
Nitrate Nitrite	4.0	0152	03/20/92	0.0002	10,000	SDWA MCLG, 40 CFR Part 141
Sulfate	301J	0381	04/01/93	0.005	–	

Table 4. (page 2 of 3)

Analyte	Maximum Detected Value[1]	Location	Log Date	Estimated Quantitation Limits[1] (ug/L)	Most Stringent Potential ARAR	Associated Regulation
Volatiles	(ug/L)			(ug/L)		
1,2-*cis*-Dichloroethene	640J	0370	03/31/93	1.0	70	SDWA MCLG, 40 CFR Part 141
1,1-Dichloroethene	1.7J	0076	02/01/91	1.3	1.3	RCRA 40 CFR 264
1,2-Dichloroethene	38J	0154	05/04/91	1.0	1	SDWA MCLG, 40 CFR Part 141
1,1,2,2-Tetrachloroethane	0.6J	0126	02/05/91	0.3	.3	RCRA 40 CFR 264
1,1,1-Trichloroethane	18J	0378	03/28/93	0.3	.3	RCRA 40 CFR 264
1,2-*trans*-Dichloroethene	6.5	0155	12/31/91	1.0	1	RCRA 40 CFR 264
1,1,2-Trichloro-1,2,2-Trifluorethane	8.7J	0076	06/16/93	2.0	–	
Benzene	3.0*	0313	09/17/92	2.0	2	RCRA 40 CFR 264
Chloroethene	4.5	0370	03/31/93	1.0	1	RCRA 40 CFR 264
Dibromomethane	20*	0063	06/22/91	2.0	2	RCRA 40 CFR 264
Dichloromethane-Methylene Chloride	13J	0313	10/31/90	5.0	5	SDWA MCL, 40 CFR Part 141
Tetrachloroethene	270J	0370	03/31/93	0.3	3	RCRA 40 CFR 264
Tetrachlormethane	4.6	0370	03/31/93	1.2	1.2	RCRA 40 CFR 264
Trichloroethene	210J	0370	03/31/93	1.2	1.2	RCRA 40 CFR 264
Trichlorofluoromethane	12	0370	03/31/93	2.0	2	RCRA 40 CFR 264
Trichloromethane	130J	0370	03/31/93	0.5	5	RCRA 40 CFR 264
Semi-Volatiles	(ug/L)			(ug/L)		
Bis(2-Ethylhexyl)Phthalate	3J	0129	03/17/92	10	10	RCRA 40 CFR 264
Butylbenzylphthalate	1J	0071	06/23/92	10	10	RCRA 40 CFR 264
Diethylphthalate	0.9J	0313	06/21/92	10	10	RCRA 40 CFR 264
Pyrene	0.7J	0063	09/16/92	10	10	RCRA 40 CFR 264
Pesticides	(ug/L)			(ug/L)		
beta-BHC	.044	0129	03/17/92	50	50	RCRA 40 CFR 264
alpha-Chlordane	0.070	0374	04/01/93	50	2	SDWA MCL, 40 CFR Part 141
Endosulfan Sulfate	0.12J	0372	03/30/93	100	100	RCRA 40 CFR 264
Heptachlor	0.11*	0126	06/16/92	50	.4	SDWA MCL, 40 CFR Part 141
Radionuclides	(pCi/L)			MDL (pCi/L)		
Actinium-227	1.6*	0071	02/01/91	~1.0	–	
Potassium-40	170*	0313	02/03/91	20	–	
Radium-226	1.72*	0313	08/04/91	1.0	5	Ohio Drinking Water Rule, O.A.C. 3745-81
Thorium-228	4.7*	0313	02/03/91	1.0	–	

Table 4. (page 3 of 3)

Analyte	Maximum Detected Value[f]	Location	Log Date	Estimated Quantitation Limits[f] (ug/L)	Most Stringent Potential ARAR	Associated Regulation
Radionuclides (continued)	(pCi/L)			MDL (pCi/L)		
Thorium-230	1.5[a]	0271	02/01/91	1.0	–	
Tritium	13800[a]	0310	10/30/90	500	20,000	SCWA MCL, 40 CFR Part 141
Uranium-234	13[a]	0313	02/03/91	1.0	–	
Uranium-235	4.7[a]	0313	02/03/91	1.0	–	
Uranium-238	4.3[a]	0313	02/03/91	1.0	–	

[a]Maximum value = Lab value; no validated value available.
[b]Criteria are pH dependent - see document.
[c]Hardness dependent criteria (400 mg/L $CaCO_3$ used)
[d]Insufficient data to develop criteria. Values present are the lowest observed effect level (LOEL).
[e]Lower value of 1.2 *cis*-dichloroethene and 1,2-*trans*-dichloroethene.
[f]Values were extracted from the Mound Plant analytical database stored on WESTON computer system in Albuquerque, NM. These values are the highest concentrations regardless of source or sampling event.

Table 5. Identification of Potential State Location-Specific ARARs for the Mound Plant

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Hazardous Waste Facility Environmental Impact/3734.05 (D)(6)(c)	A hazardous waste facility installation and operation permit shall not be approved unless it proves that the facility is proven to represent the minimum adverse environmental impact, considering the state of available technology, the nature and economics of various alternatives, and other pertinent considerations.	Pertains to all sites at which hazardous waste has come to be located and/or at which hazardous waste will be treated, stored, or disposed of. May function as siting criteria.	ARAR	While no permit is required, remedial alternatives will be coordinated with the U.S. EPA and Ohio EPA.
Hazardous Waste Siting Criteria/3734.05 (D)6,d,g,h	(D),6,d. A hazardous waste facility installation and operation permit shall not be approved unless the facility is proven to represent the minimum risk of all of the following: (i) Contamination of ground and surface waters (ii) Fires or explosions from treatment, storage, or disposal methods (iii) Accident during transportation (iv) Impact on public health and safety (v) Air pollution (vi) Soil contamination (D),6,g,h. Prohibits the following locations for treatment, storage, and disposal of acute hazardous waste: (i) Within 2,000 feet of any residence, school, hospital, jail, or prison (ii) Any naturally occurring wetland (iii) Any flood hazard area (iv) Within any state park or national park or recreation area.	Pertains to all sites at which hazardous waste has come to be located and/or at which hazardous waste will be treated, stored, and disposed of. May function as siting criteria.	ARAR	While no permit is required, remedial alternatives will be coordinated with the U.S. EPA and Ohio EPA.
Solid Waste Facility Prohibited in Parklands/3734.11 (C)	Prohibits the siting of any solid waste facility within state park, national park, or national recreation area.	Pertains to sites located within parklands. May function as siting criteria.	Not ARAR	No parks or national recreation areas exist within Operable Unit 1.
Water Use Designations for Southwest Ohio Tributaries/ 3745-1-17	Establishes water use designations for stream segments within the Southwest Ohio Tributaries Basin.	Pertinent if stream or stream segment is onsite and is affected by site conditions or if remedy includes direct discharge. Used by DWQPA to establish waste load allocations.	Not ARAR	Not an ARAR because stream segment does not occur in Operable Unit 1; however, it is applicable to discharge.

Table 5. (page 2 of 2)

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Water Use Designations for Great Miami River/ 3745-1-21	Establishes water use designations for stream segments within the Great Miami River Basin.	Pertinent if stream or stream segment is onsite and is affected by site conditions or if remedy includes direct discharge. Used by DWQPA to establish waste load allocations.	Not ARAR	Not an ARAR because stream segment does not occur in Operable Unit 1; however, it is applicable to discharge.
Standard for Inactive Asbestos Waste Disposal Sites/ 3745-20-07 A,B,C	Establishes emissions and maintenance standards for inactive asbestos waste disposal sites.	Pertains to sites where asbestos has come to be located. Consider for landfills with inadequate cover or where wastes will be consolidated.	Not ARAR	Operable Unit 1 is not a current or historic asbestos waste disposal area.
Sanitary Landfill Explosive Gas Monitoring/ 3745-27-12 A,B,D,E,MN	Establishes when an explosive gas monitoring plan is required for solid waste landfills. Specifies the minimum information required in such a plan, including detailed engineering plans, specifications, information on gas generation potential, sampling and monitoring procedures, etc. Mandates when repairs must be made to an explosive gas monitoring system. This rule only applies to landfills that received "putrescible" solid wastes.	Pertains to any site that has had or will have putrescible solid wastes placed onsite and that has a residence or other occupied structure located within 1,000 feet of the emplaced solid waste.	Not ARAR	Putrescible solid waste has not and will not be disposed of in Operable Unit 1.
Location Standards for Hazardous Waste Treatment/Storage/Disposal Facilities/ 3745-54-18 A,B,C	Restricts the siting of hazardous waste facilities in areas of seismic activity or floodplains.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	Not ARAR	None of the prescribed restricted locations occur within Operable Unit 1.

Table 6. Identification of Potential Federal Location-Specific ARARs for the Mound Plant

Standard Requirement, Criterion, or Limitation/ Citation	Description	ARAR	Comment
Historic Sites, Building and Antiquities Act/16 USC 470 *et seq.*; 36 CFR Part 800	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts upon such landmarks.	Not ARAR	Proposed activities are not located near any landmark included in the National Registry of Natural Landmarks.
National Historic Preservation/ 16 USC Sec. 470; 40 CFR Sec. 6.301(B)	Requires Federal agencies to take into account the effect of any Federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the national register of historic places.	Not ARAR	Proposed activities are not located near any historical site or building eligible for listing or currently listed in the national register of historic places.
Archaeological and Historic Preservation/16 USC Sec. 469; UAC, Title 63; Chapter 18; UAC R224	Establishes procedures to provide for preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program.	Not ARAR	Proposed activities are not located near any historical or archaeological site.
Endangered Species Act/ 16 USC Sec. 1531-1543; 50 CFR Parts 200.402; 33 CFR Parts 320-330	Requires that Federal agencies ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	Not ARAR	Proposed activities will not adversely affect endangered or threatened species. No endangered or threatened species have been found to exist in Operable Unit 1.
Executive Order on Protection of Wetlands/Exec. Order #11,990; 40 CFR Sec. 6.302(A) and Appendix A; 40 CFR Parts 230,231	Requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Actions must not discharge dredged or fill material into wetlands without a permit.	Not ARAR	Proposed activities will not adversely affect wetlands. No wetlands have been found to exist in Operable Unit 1.
Area Affecting Stream or River/40 CFR 6.302	Action must protect fish or wildlife.	Not ARAR	Proposed action will protect potentially affected fish and wildlife resources. No actionable criteria.
Fault Zone/40 CFR 264.18(a)	RCRA regulations specify that hazardous waste treatment, storage, or disposal must not take place within 200 feet of a Holocene fault.	Not ARAR	No Holocene faults exist within 200 feet of Operable Unit 1.

Table 6. (page 2 of 2)

Standard Requirement, Criterion, or Limitation/ Citation	Description	ARAR	Comment
Flood Plain/40 CFR 244.18(b)	Any RCRA treatment, storage, or disposal facility that lies within a 100-year flood plain must be designed, constructed, and operated to avoid washout.	Not ARAR	This site is not located within a 100-year flood plain (FEMA 1993).
Underground Mine, Cave, or Salt Dome Formation/40 CFR 264.18(c)	RCRA regulations specify that the placement of non-containerized or bulk liquid hazardous waste is prohibited.	Not ARAR	Hazardous waste will not be placed within an underground mine, cave, or salt dome.
Wilderness Area/Wilderness Act (6 USC 1131 *et seq.*); 50 CFR 35.1 *et seq.*	Area must be administered in such manner as will leave it unimpaired as wilderness and to preserve its wildness.	Not ARAR	Proposed activities will not adversely affect wilderness areas. No wilderness areas are present in Operable Unit 1.
Wildlife Refuge/16 USC 688 dd *et seq.*; 50 CFR Part 27	Only actions allowed under the provisions of 16 USC Section 668 DD(c) may be undertaken in areas that are part of the National Wildlife Refuge System.	Not ARAR	Proposed activities will not adversely affect wildlife refuge areas. No wildlife refuge areas are present in Operable Unit 1.
Within Area Affecting National Wild, Scenic, or Recreational River/Wild and Scenic Rivers Act (16 USC 661 *et seq.*; 40 CFR 6.302	Diversion, channeling or other activity that modifies a stream or river and affects fish or wildlife is prohibited.	Not ARAR	Proposed activities will not adversely affect national wild, scenic, or recreational rivers. No such rivers are present in Operable Unit 1.
Coastal Zone/16 USC Section 1451 *et seq.*	Conduct activities in a manner so as not to affect the coastal zone including lands therein and thereunder and adjacent shorelands.	Not ARAR	Proposed activities are not located near a coastal zone.
Coastal Barrier/16 USC 3501 *et seq.*	Prohibits Federal expenditure within the Coastal Barrier Resource System.	Not ARAR	Proposed activities are not located near a coastal barrier.

Table 7. Potential State Action-Specific ARARs

Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Construction Permits for Dams, Dikes and Levees/3521.06	No dam may be constructed for the purpose of storing, conserving, or retarding water or for any other purposes, nor shall any dike or levee be constructed for the purpose of diverting or retaining flood water without a permit.	The substantive requirements of this section pertain to remedies that will create or alter a dam, dike, or levee. Consider for sites with onsite surface water and for sites within a floodplain.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee.
Monitoring, Maintenance, and Operation (Dams, Dikes, Levees)/3521.062	Dams, dikes, and levees (and all appurtenances) shall be monitored, maintained, and operated safely in accordance with state rules, terms, and conditions of the permit and other requirements issued pursuant to this section or section 1521.06 of the ORC.	The substantive requirements of this section pertain to remedies that will create or alter a dam, dike, or levee. Consider for sites with onsite surface water and for sites within a floodplain.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee. No such structures exist within Operable Unit 1.
Prohibits Violation of Air Pollution Control Rules/3704.05 A-I	Prohibits emission of an air contaminant in violation of section 3704 or any rule, permit, order, or variance issued pursuant to that section of the ORC.	May pertain to any site where air contaminant emissions occur either as a pre-existing condition of the site or as a result of remedial activities. Should be considered for virtually all sites.	Not ARAR	This is effectively a provision that gives Ohio EPA the authority to enforce state air regulations and permits. Implementation of the substantive provisions of state air requirements as ARARs is required by Section 121(d) of CERCLA.
Demolition Debris Facilities - Violations Prohibited/3714.13	Prohibits violations of any section of chapter 3714 concerning construction and demolition debris disposal facilities or any rule or order issued pursuant to it. Disposal of asbestos is specifically prohibited without authorization.	Pertains to construction and demolition debris facilities where hazardous waste or hazardous constituents have come to be located. Consider for sites where remedial action will include demolition of structures or where asbestos has come to be located.	Not ARAR	This is effectively a provision that gives Ohio EPA the authority to enforce state disposal regulations and permits. Implementation of the substantive provisions of state disposal requirements as ARARs is required by Section 121(d) of CERCLA.
Unauthorized Storage, Treatment/Disposal of Hazardous Waste/3734.02 (F)	Prohibits storage, treatment, or disposal of hazardous waste except at permitted facilities.	Pertains to any site at which hazardous waste has come to be located.	Not ARAR	This is effectively a provision that gives Ohio EPA the authority to enforce state hazardous waste regulations and permits. Implementation of the substantive provisions of state hazardous waste requirements as ARARs is required by Section 121(d) of CERCLA.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
"Digging" Where Hazardous or Solid Waste Facility Was Located/3734.02 (H)	Filling, grading, excavating, building, drilling or mining on land where hazardous waste or solid waste facility was operated is prohibited without prior authorization from the Director of the Ohio EPA.	Pertains to any site at which hazardous or solid waste has come to be located.	Not ARAR	Not a substantive requirement. Implementation of the substantive provisions of state requirements relating to intrusive activities at former disposal sites as ARARs is required by Section 121(d) of CERCLA.
Air Emissions from Hazardous Waste Facilities/3734.02 I	No hazardous waste facility shall emit any particulate matter, dust, fumes, gas, mist, smoke, vapor, or odorous substance that interferes with the comfortable enjoyment of life or property or is injurious to public health.	Pertains to any site at which hazardous waste will be managed such that air emissions may occur. Consider for sites that will undergo movement of earth or incineration.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure emissions are within acceptable limits.
Standards for Infectious Waste Handling and Treatment/3734.02.1	Establishes standards for generators, transporters, and owner operators of treatment facilities for infectious waste.	Pertains to all sites at which infectious waste has come to be located and/or infectious waste might be commingled with any other type of waste.	Not ARAR	No infectious wastes will be involved in remedial activities at Operable Unit 1.
Handling Low-Level Radioactive Waste Prohibited/3734.02.7 A,B	A) Prohibits commingling low-level radioactive waste with any type of solid waste, hazardous waste, or infectious waste, B) no owner or operator of a solid, infectious, or hazardous waste facility shall accept for transfer, storage, treatment, or disposal of any radioactive waste.	Pertains to all sites at which low- level radioactive waste has come to be located.	ARAR	In general, radioactive wastes generated as part of remedial actions at Operable Unit 1 will be managed separately from non-radioactive materials.
Prohibits Open Dumping or Burning/3734.03	Prohibits open burning or open dumping of solid waste or treated or untreated infectious waste.	Pertains to any site at which solid waste has come to be located or will be generated during a remedial action.	Not ARAR	None of the alternatives involve open burning or dumping.
Hazardous Waste Facility Environmental Impact/3734.05 (D)(6)(c)	A hazardous waste facility installation and operation permit shall not be approved unless that the facility proves to represent the minimum adverse environmental impact, considering the state of available technology, the nature and economics of various alternatives, and other pertinent considerations.	Pertains to all sites at which hazardous waste has come to be located and/or at which hazardous waste will be treated, stored, or disposed of. May function as siting criteria.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Hazardous Waste Siting Criteria/3734.05 (D)6,d,g,h	(D),6,d. A hazardous waste facility installation and operation permit shall not be approved unless it proves that the facility represents the minimum risk of all of the following: (i) Contamination of ground and surface waters (ii) Fires or explosions from treatment, storage, or disposal methods (iii) Accident during transportation (iv) Impact on public health and safety (v) Air pollution (vi) Soil contamination (D),6,g,h. Prohibits the following locations for treatment, storage, and disposal of acute hazardous wastes: (i) Within 2000 feet of any residence, school, hospital, jail, or prison; (ii) Any naturally occurring wetland (iii) Any flood hazard area (iv) Within any state park or national park or recreation area	Pertains to all sites at which hazardous waste has come to be located and/or at which hazardous waste will be treated, stored, or disposed of. May function as siting criteria.	ARAR	Units constructed as part of any of these alternatives or to manage hazardous wastes (or similar wastes) will comply.
Conditions for Disposal of Acute Hazardous Waste/3734.14.1	Prohibits disposal of acute hazardous waste unless it: (1) cannot be treated, recycled, or destroyed; (2) has been reduced to its lowest level of toxicity; and (3) has been completely encapsulated or protected to prevent leaching.	Pertains to any site where acute hazardous waste has come to be located.	ARAR	Based on available information, only one waste disposed of prior to construction of the sanitary landfill, beryllium machining wastes, may be determined to be an acute hazardous waste. Currently, there is some question whether such wastes would have been considered off-specification commercial chemical products, identifiable as P015 listed acute hazardous wastes. If such a listing is appropriate, this standard will be regarded as ARAR for any alternatives involving generation of listed beryllium hazardous wastes.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Prohibition of Nuisances/3767.13	Prohibits noxious exhalations or smells and the obstruction of waterways.	Pertains to any site that may have noxious smells or may obstruct waterways.	ARAR	Odors produced during construction/implementation of remedial actions at Operable Unit will be minimized or eliminated. Alternatives do not involve activities that could obstruct waterways.
Prohibition of Nuisances/3767.14	Prohibition against throwing refuse, oil, or filth into lakes, streams, or drains.	Pertains to all sites located adjacent to lakes, streams, or drains.	ARAR	
Conservancy Districts/6101.19	Board of directors of a conservancy district may make and enforce rules and regulations pertaining to channels, ditches, pipes, sewers, etc.	This statute pertains to any site that may affect a construction within a conservancy district.	Not ARAR	Requirements to be applied to alternatives will be identified during the CERCLA ARARs process.
Acts of Pollution Prohibited/6111.04	Pollution of waters of the state is prohibited.	Pertains to any site that has contaminated onsite surface or groundwater or will have a discharge to onsite surface or groundwater.	Not ARAR	This is effectively a provision that gives Ohio EPA the authority to enforce state water regulations and permits. Implementation of the substantive provisions of state water requirements as ARARs is required by Section 121(d) of CERCLA.
Rules Requiring Compliance with National Effluent Stds/6111.04.2	Establishes regulations requiring compliance with national effluent standards.	Pertains to any site that will have a point source discharge.	ARAR	Alternatives involving onsite discharge will comply.
Injection of Sewage or Wastes into Wells/6111.04.3	Establishes a regulatory program for the injection of wastes into wells that prevents the contamination of underground sources of drinking water.	Pertains to any site that either has or intends to inject wastes of any type into wells.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Water Pollution Control Requirements-Duty to Comply/6111.07 A,C	Prohibits failure to comply with requirements of sections 6111.01 to 6111.08 or any rules permit, or order issued under those sections.	Pertains to any site that has contaminated groundwater or surface water or will have a discharge to onsite surface or groundwater.	Not ARAR	This is effectively a provision that gives Ohio EPA the authority to enforce state water regulations and permits. Implementation of the substantive provisions of state water requirements as ARARs is required by Section 121(d) of CERCLA.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Particulate Ambient Air Quality Standards/ 3745-17-02 A,B,C	Establishes specific standards for total suspended particulates.	Pertains to any site that may emit measurable quantities of particulate matter (both stack and fugitive). Consider for sites that will undergo excavation, demolition, cap installation, clearing and grubbing, incineration, and waste fuel recovery.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure particulate emissions are within acceptable limits.
Particulate Nondegradation Policy/3745-17-05	Degradation of air quality in any area where air quality is better than required by 3745-17-02 is prohibited.	Pertains to sites in certain locations that may emit or allow the escape of particulates (both stack and fugitive). Consider for sites that will undergo excavation, demolition, cap installation, clearing and grubbing, and incineration.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure particulate emissions are within acceptable limits.
Visible Particulate Emission Control/ 3745-17-07 A-D	Specifies the allowable opacity for particulate emissions. Provides exceptions for uncombined water, start-up/ shutdown of fuel burning equipment, and malfunctions.	Pertains to any emission of particulate from a stack. Consider for incineration and fuel burning.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure particulate emissions are within acceptable limits.
Open Burning Standards in Restricted Areas/3745-19-03 A,B,C,D	Open burning without prior authorization from the Ohio EPA is prohibited.	Pertains to sites within a restricted area (outside the boundary of a municipality and a zone extending beyond such municipality).	Not ARAR	Alternatives do not include open burning.
Open Burning Standards in Unrestricted Areas/3745-19-04 A,B,C,D	Open burning without prior authorization from the Ohio EPA is prohibited.	Pertains to sites within an unrestricted area (within the boundary of a municipality and a zone extending beyond such municipality).	Not ARAR	Alternatives do not include open burning.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Location Criteria for Solid Waste Disposal Permit/3745-27-07 A,B	Specifies locations in which solid waste landfills are not to be sited. Includes floodplains, sand, or gravel pits, limestone or sandstone quarries, areas above sole source aquifers, wetlands, etc.	This rule prevents the establishment of new solid waste landfills and expansions of existing solid waste landfills in certain unfavorable locations. Also may prohibit the leaving of waste in-place in certain unfavorable locations.	ARAR	Historic waste disposal occurred above the sole source aquifer.
Disturbances Where Hazardous or Solid Waste Facility Was Operated/3745-27-13 A,E-G,J	Prohibits any filling, grading, excavating, building, drilling, or mining on land where a hazardous waste facility or solid waste facility was operated without prior authorization from the Director of the EPA. Special terms to conduct such activities may be imposed by the director to protect the public and the environment.	Pertains to any site at which hazardous or solid waste has been managed, either intentionally or otherwise. Doe not pertain to areas that have had one-time leaks or spills.	Not ARAR	Not a substantive requirement. Implementation of the substantive provisions of state requirements relating to intrusive activities at former disposal sites as ARARs is required by Section 121(d) of CERCLA.
Requirements for Ignitable Reactive or Incompatible Hazardous Wastes/3745-54-17 A,B,C	Presents general precautions to prevent accidental ignition or reaction of ignitable, reactive, or incompatible wastes.	Pertains to any site at which potentially reactive, ignitable, or incompatible wastes are present.	ARAR	Alternatives involving management of reactive, ignitable, or incompatible wastes will comply.
Predesign Investigations (Dams, Dikes, Levees)/ 3501:21-11 03-05	Presents predesign requirements for dams, dikes, and levees. Includes onsite construction material data, surveys, and hydrologic and hydraulic investigations.	Pertains to remedies that create or alter a dam, dike, or levee. Consider for sites with onsite surface water and for sites within a floodplain.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee.
Additional Design Requirements for Dams/ 3501:21-13 02-08	Presents design requirements specific to dams. Includes such criteria as design storm and flood, spillway design, freeboard requirements, etc.	Pertains to remedies that create or alter a dam. Consider for sites with onsite surface water.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee.
Additional Design Requirements for Dikes, and levees/ 3501:21-13 10-14	Presents design requirements specific to dikes, and levees. Includes criteria such as design storm and flood and freeboard requirements.	Pertains to remedies that create or alter a dike, or levee. Consider for sites within a floodplain.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Operation, Maintenance, and Inspections/ 3501:21-15 06	Presents the minimum information required in a plan addressing the operation, maintenance, and inspection of dams, dikes, and levees.	Pertains to remedies that create or alter a dam, dike, or levee. Consider for sites with onsite surface water and for sites within a floodplain.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee.
Deficiency and O&M of Dams, Dikes, and Levees/ 3501:21-21 03-04	Dams, dikes, and levees must be operated safely. Repairs or other remedial measures shall be performed on dams, dikes, and levees as necessary to safeguard life, health, or property.	Pertains to remedies that create or alter a dam, dike, or levee. Consider for sites with onsite surface water and for sites within a floodplain.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee.
Design Requirements for Dams, Dikes, and Levees/ 3501:21-5 02-06	Specifies minimum information required during design for Ohio DNR to determine adequacy of proposed dam, dike, or levee. Includes design reports, plans, and specifications.	Pertains to remedies that create or alter a dam, dike, or levee. Consider for sites with onsite surface water and for sites within a floodplain.	Not ARAR	Alternatives do not involve construction or modification of a dam, dike, or levee.
Analytical and Collection Procedures/3745-1-03	Specifies analytical methods and collection procedures for surface water discharges.	Pertains both to discharges to surface waters as a result of remediation and to any onsite surface waters affected by site conditions.	ARAR	Alternatives involving direct discharge will comply.
"Five Freedoms" for Surface Water/ 3745-1-04 A,B,C,D,E	All surface waters of the state shall be free from: A) Objectionable suspended solids. B) Floating debris, oil, and scum. C) Materials that create a nuisance. D) Toxic, harmful, or lethal substances. E) Nutrients that create nuisance growth.	Pertains both to discharges to surface waters as a result of remediation and to any onsite surface waters affected by site conditions.	ARAR	Alternatives involving direct discharge will comply.
Antidegradation Policy for Surface Water/ 3745-1-05 A,B,C	Prevents degradation of surface water quality below designated use or existing water quality. Existing instream uses shall be maintained and protected. The most stringent controls for treatment shall be required by the Director of the EPA for all new and existing point source discharges. Prevents any degradation of "State Resource Waters."	Requires that best available technology be used to treat surface water discharges. DWQPA uses this rule to set standards when existing water quality is better than the designated use.	ARAR	Alternatives involving direct discharge will comply.
Mixing Zones for Surface Water/ 3745-1-06 A,B	A) Presents the criteria for establishing non-thermal mixing zones for point source discharges. B) Presents the criteria for establishing thermal mixing zones for point source discharges.	Applied as a term of discharge permit to install.	ARAR	Alternatives involving direct discharge will comply.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Water Quality Criteria/ 3745-1-07 C	Establishes water quality criteria for pollutants that do not have specific numerical or narrative criteria identified in Tables 7-1 through 7-15 of this rule.	Pertains both to discharges to surface waters as a result of remedial action and to any surface waters affected by site conditions.	ARAR	Alternatives involving direct discharge will comply.
Water Use Designations for Great Miami River/3745-1-21	Establishes water use designations for stream segments within the Great Miami River Basin.	Pertinent if stream or stream segment is onsite and is affected by site conditions or if remedy includes direct discharge. Used by DWQPA to establish waste load allocations.	ARAR	Alternatives involving direct discharge will comply.
Water Use Designations for Ohio River/3745-1-32	Establishes water use designations for stream segments within the Ohio River Basin.	Pertinent if stream or stream segment is onsite and is affected by site conditions or if remedy includes direct discharge. Used by DWQPA to establish waste load allocations.	Not ARAR	No site drainage has or will impact the subject stream segment.
Malfunction and Maintenance of Air Pollution Control Equipment/ 3745-15-06 A1,A2	Establishes scheduled maintenance and specifies when pollution source must be shut down during maintenance.	Pertains to any site that utilizes or will utilize air pollution control equipment onsite.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure emissions are within acceptable limits.
Air Pollution Nuisances Prohibited/ 3745-15-07 A	Defines air pollution nuisance as the emission or escape into the air from any source(s) of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors, and combinations of the above that endanger health, safety, or welfare of the public or cause personal injury or property damage. Such nuisances are prohibited.	Pertains to any site that causes, or may reasonably cause, air pollution nuisances. Consider for sites that will undergo excavation, demolition, cap installation, methane production, incineration, and waste fuel recovery.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure emissions are within acceptable limits.
Stack Height Requirements/ 3745-16-02 B,C	Establishes allowable stack height for air contaminant sources based on good engineering practice.	Pertains to any site that has or will have an air contaminant source onsite (particulate, dust, fumes, gas, mist, smoke, vapor, odors) emitted from a stack. Consider for remedies incorporating incinerations, waste fuel recovery, and wastewater treatment.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Controls for air emissions will be compliant with these standards.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Emission Restrictions for Fugitive Dust/ 3745-17-08 A1,A2,B,D	All emissions of fugitive dust shall be controlled.	Pertains to sites that may have fugitive emissions (non-stack) of dust. Consider for sites that will undergo grading, loading operations, demolition, clearing and grubbing, and construction.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure fugitive dust emissions are within acceptable limits.
Incinerator Particulate Emission and Odor Restrictions/ 3745-17-09 A,B,C	Establishes particulate emission limitations and design-operation requirements to prevent the emission of objectionable odors.	Pertains to any remedy incorporating incineration.	Not ARAR	None of the alternatives considered involve incineration.
Fuel Burning Particulate Emission Restrictions/ 3745-17-10 A,B,C	Establishes particulate emission limitations for fuel burning equipment.	Pertains to any remedy incorporating fuel burning (waste fuel recovery).	Not ARAR	None of the alternatives considered involve incineration.
Sulfur Dioxide Ambient Air Quality Standards/ 3745-18-02 A,B,C,D	Establishes primary and secondary ambient air quality standards for sulfur dioxide.	Pertains to any site that emits or will emit sulfur dioxide. Consider for incineration, and fuel burning (waste fuel recovery).	Not ARAR	None of the alternatives considered involve incineration.
Sulfur Dioxide Measurement Methods and Procedures/ 3745-18-04 A,B,C,E,F	Specifies testing methods and procedures for sulfur dioxide emissions compliance testing.	Pertains to any site that will emit sulfur dioxide. Consider for sites that will utilize incineration or fuel burning (waste fuel recovery).	Not ARAR	Activities that could emit sulfur dioxide are not part of any of the alternatives.
Sulfur Dioxide Ambient Monitoring Requirements/ 3745-18-05 A	The Director of the Ohio EPA may require any source of sulfur dioxide emissions to install, operate, and maintain monitoring devices; maintain records and file reports; and file reports.	Pertains to any site that emits or will emit sulfur dioxide. Consider for incineration, and fuel burning (waste fuel recovery).	Not ARAR	Activities that could emit sulfur dioxide are not part of any of the alternatives.
Sulfur Dioxide Emission Limit Provisions/ 3745-18-06 A-G	Establishes general limit provisions for sulfur dioxide.	Pertains to any site that will emit sulfur dioxide. Consider for sites that will undergo incineration or fuel burning (waste fuel recovery).	Not ARAR	Activities that could emit sulfur dioxide are not part of any of the alternatives.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Standards for Active Asbestos Waste Disposal Sites/ 3745-20-06 A,B	Establishes operating standards for an active asbestos waste disposal site	Pertains to sites where asbestos has come to be located and must be consolidated onsite. Consider for landfills where wastes will be excavated and re-deposited onsite.	Not ARAR	Management of asbestos wastes is not a part of any of the alternatives.
Standards for Inactive Asbestos Waste Disposal Sites/3745-20-07 A,B,C	Establishes emissions and maintenance standards for inactive asbestos waste disposal sites.	Pertains to sites where asbestos has come to be located. Consider for landfills where wastes will be excavated and redeposited onsite.	Not ARAR	Management of asbestos wastes is not a part of any of the alternatives.
Ambient Air Quality Standards and Guidelines/3745-21-02 A,B,C	Establishes specific air quality standards for carbon monoxide, ozone and non-methane hydrocarbons.	Pertains to any site that will emit carbon oxides, ozone or non-methane hydrocarbons. Consider for sites that will undergo water treatment, incineration and fuel burning (waste fuel recovery).	ARAR	Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure emissions are within acceptable limits.
Methods of Ambient Air Quality Measurement/ 3745-21-03 B,C,D	Specifies measurement methods to determine ambient air quality for the following constituents: carbon monoxide, ozone, and non-methane hydrocarbons.	Pertains to any site that will emit carbon monoxide ozone, or non-methane hydrocarbons. Consider for sites where treatment systems will result in air emissions.	ARAR	Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure emissions are within acceptable limits.
Non-degradation Policy/3745-21-05	Prohibits significant and avoidable deterioration of air quality.	Pertains to any site that will emit carbon oxides and non-methane hydrocarbons. Consider for sites that will undergo water treatment, incineration, and fuel burning (waste fuel recovery).	ARAR	Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure emissions are within acceptable limits.
Organic Materials Emission Control; Stationary Sources/3745-21-07 A,B,G,I,J	Requires control of emissions of organic materials from stationary sources, and best available technology.	Pertains to any site that is emitting or will emit organic material. Consider for sites that will undergo water treatment, incineration, and fuel burning (waste fuel recovery).	ARAR	Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure organic materials emissions are within acceptable limits.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Carbon Monoxide Emission Control: Stationary Sources/3745-21-08 A-E	Requires any stationary source of carbon monoxide to minimize emissions by the use of best available control technologies and operating practices in accordance with best current technology.	Pertains to any site that is emitting or will emit carbon monoxide. Consider for sites that will undergo water treatment (air stripping), incineration, and fuel burning (waste fuel recovery).	ARAR	Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure carbon monoxide emissions are within acceptable limits.
VOC Emissions Control: Stationary Sources/3745-21-09	Establishes limitations for emissions of volatile organic compounds from stationary sources.	Pertain to any site that is emitting or will emit VOCs. Consider for sites that will undergo water treatment.	ARAR	Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure VOC emissions are within acceptable limits.
Nitrogen Dioxide Ambient Air Quality Standards/3745-23-01	Establishes a maximum ambient air quality standard for nitrogen dioxide.	Pertains to any site that is emitting or will emit nitrogen dioxide. Consider for sites that will undergo water treatment, incineration, and fuel burning (waste fuel recovery).	Not ARAR	Activities that could emit nitrogen dioxide are not part of any of the alternatives
Measurement Methods for Nitrogen Dioxide/ 3745-23-02 A,B	Specifies methods of measurement for nitrogen dioxide to determine ambient air quality.	Pertains to any site that will emit nitrogen dioxide. Consider for sites where treatment systems may result in nitrogen dioxide emissions, especially thermal treatment systems.	Not ARAR	Activities that could emit nitrogen dioxide are not part of any of the alternatives
Nitrogen Dioxide Nondegradation Policy/3745-23-04	Prohibits the significant and avoidable deterioration of air quality by the release of nitrogen dioxide emissions.	Pertains to any site that is emitting or will emit nitrogen dioxide. Consider for sites that will undergo water treatment, incineration, and fuel burning (waste fuel recovery).	Not ARAR	Activities that could emit nitrogen dioxide are not part of any of the alternatives
Nitrogen Oxides Emission Controls: Stationary Source/ 3745-23-06	Requires that all stationary sources of nitrogen oxide minimize emissions by the use of the latest available control techniques and operating practices in accordance with best current technology. Establishes limit for nitrogen oxide emissions from combustion.	Pertains to any site that will emit nitrogen oxide. Consider for sites where treatment systems will result in nitrogen oxide emissions, especially thermal treatment.	Not ARAR	Activities that could emit nitrogen dioxide are not part of any of the alternatives

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Emission Control Action Programs/ 3745-26-03	Requires preparation for air pollution alerts, warnings, and emergencies.	Pertains to any site that is emitting or may emit air contaminants.	Not ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Development of alternatives involving air emissions will be include provisions for air pollution alerts, warnings, and emergencies.
Exemptions to Solid Waste Regulations/ 3745-27-03	Defines exemptions to solid waste regulations and establishes limitations on temporary storage of putrescible waste or any solid waste that causes a nuisance or health hazard. Storage of putrescible waste beyond 7 days is considered open dumping.	Pertains to any site at which solid waste will be managed. Consider especially for old landfills where solid waste may be excavated and/or consolidated.	ARAR	Will be applied to any alternative that involves generation of solid wastes.
Authorized, Limited and Prohibited Solid Waste Disposal/ 3745-27-05 A,B,C	Establishes allowable methods of solid waste disposal: sanitary landfill, incineration, composting. Prohibits management by open burning and open dumping.	Pertains to any site at which solid wastes will be managed. Prohibits management by open burning and open dumping.	ARAR	Will be applied to any alternative that involves generation of solid wastes. None of the alternatives involve open burning or open dumping.
Sanitary Landfill Facility Permit to Install 3745-27-06	Specifies the minimum technical information required of a solid waste permit to install. Included are a hydrogeologic investigation report, leachate production and migration information, surface water discharge information, design calculations, and plan drawings.	This paragraph presents substantive requirements of a solid waste permit to install. Pertains to any new solid waste disposal facility created onsite and expansions of existing solid waste landfills. Also pertains to existing areas of contamination that are capped per solid waste rules. This rule establishes the minimum information required during the remedial design stage.	ARAR	Will be applied to any activities that involve modification of the closed sanitary landfill.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Construction Specifications for Sanitary Landfills/3715-27-08	Specifies the minimum requirements for the soil/clay layers, granular drainage layer, geosynthetics, leachate management system, gas monitoring system, etc. Also establishes construction requirements for facilities to be located in geologically unfavorable areas.	Pertains to any new solid waste disposal facility created onsite and any expansions to existing solid waste landfills. Portions also pertain to areas of contamination that are capped per solid waste rules. May serve as siting criteria.	ARAR	Will be applied to any activities that involve modification of the closed sanitary landfill.
Sanitary Landfill Operational Criteria/ 3745-27-19	Specifies operational requirements for solid waste landfills. Includes leachate and air emission management, filling of new phase, access roads, daily cover, compatibility testing, burning waste, layer thickness, disposal of liquids, and surface water management.	Pertains to new solid waste disposal facilities to be created onsite and existing landfills that will be expanded during remediation. Portions also may pertain to existing areas of contamination that will be capped in-place per solid waste rules.	ARAR	Will be applied to any activities that involve modification of the closed sanitary landfill.
Sanitary Landfill - Groundwater Monitoring/ 3745-27-10	Groundwater monitoring program must be established for all sanitary landfill facilities. The system must consist of a sufficient number of wells that are located so that samples indicate both upgradient (background) and downgradient water samples. The system must be designed for the minimum requirements specified in this rule. The sampling and analysis procedures used must comply with this rule.	Pertains to any new solid waste facility and any expansions of existing solid waste landfills onsite. Also may pertain to existing areas of contamination that are capped in place per the solid waste rules.	ARAR	Requirements for design and operation of a groundwater monitoring system will be incorporated into all but the no-action alternative.
Final Closure of Sanitary Landfill Facilities/3745-27-11	Specifies the minimum information necessary for the Ohio EPA to determine the adequacy of closure methods for solid waste landfills. Specifies acceptable cap design: soil, barrier layer, granular drainage layer, and soil, and vegetative layer.	Substantive requirements pertain to new solid waste landfills created onsite, expansions of existing solid waste landfills onsite, and existing areas of contamination that are capped in-place per the solid waste rules.	ARAR	Evaluation of existing closed sanitary landfill conditions will be included in all but the no-action alternative and necessary modifications/repairs will be made.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Explosive Gas Monitoring for Sanitary Landfills/3745-27-12	Identifies parameters and schedule for explosive gas monitoring.	Pertains to any disposal site where explosive gas generation and migration may be a threat.	ARAR	Alternatives involve leaving sanitary landfill in-place. The landfill will be evaluated for gas-generating conditions and any necessary monitoring and/or venting measures will be implemented.
Post-Closure Care of Sanitary Landfill Facilities/3745-27-14	Specifies the required post-closure care for solid waste facilities. Includes continuing operation of leachate and surface water management systems, maintenance of the cap system, and groundwater monitoring.	Substantive requirements pertain to newly created solid waste landfills onsite, expansions of existing solid waste landfills onsite and existing areas of contamination that are capped per the solid waste rules.	ARAR	Evaluation of existing closed sanitary landfill conditions will be included in all but the no-action alternative and necessary modifications/repairs will be made.
Solid Waste Incinerator Operations/3745-27-50-53	Establishes operational requirements for solid waste incinerators.	Pertains to any site at which solid waste will be incinerated onsite.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of incineration.
Industrial Solid Waste Landfill Permit to Install/3745-29-06	Specifies technical information required of a solid waste landfill permit to install. Included are all design plans and calculations, hydrogeologic investigation, leachate management calculations, and other operational information.	Pertains to any new industrial solid waste disposal facility created onsite and expansions of existing solid waste landfills.	ARAR	Will be applied to any activities that involve modification of the closed landfill.
Additional Criteria for Industrial Solid Waste Landfill Permit to Install/3745-29-07	Presents, in part, criteria for approval of environmental improvements and location restrictions to industrial solid waste landfill facilities.	Pertains to any modifications to existing solid waste disposal facilities.	ARAR	Will be applied to any activities that involve modification of the closed landfill.
Industrial Solid Waste Landfill Facility Construction/3745-29-08	Specifies minimum requirements for all aspects of solid waste landfill construction.	Pertains to any new industrial solid waste landfill facility onsite and any expansions or modifications to existing solid waste landfills.	ARAR	Will be applied to any activities that involve modification of the closed sanitary landfill.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Industrial Solid Waste Landfill Groundwater Monitoring Program/3745-29-10	Specifies requirements for a solid waste landfill groundwater monitoring program. Included are number of wells, sampling frequency, procedures, and other information.	Pertains to any new solid waste landfill or any modifications to an existing landfill.	ARAR	Requirements for design and operation of a groundwater monitoring system will be incorporated into all but the no-action alternative.
Final Closure of an Industrial Solid Waste Landfill/3745-29-11	Specifies minimum information necessary for the OEPA to determine the adequacy of closure methods for industrial solid waste landfills.	Pertains to any new solid waste landfills created onsite and any expansions of existing solid waste landfills.	ARAR	Evaluation of the closed sanitary landfill conditions will be included in all but the no-action alternative. Necessary modification and repairs will be made.
Post-Closure Care/ 3745-29-14	Specifies required post-closure care for industrial solid waste landfills including continuing leachate and surface water management, cap maintenance, and groundwater monitoring.	Pertains to newly created solid waste landfills onsite and expansions of existing landfills.	ARAR	Evaluation of existing closed sanitary landfill conditions will be included in all but the no-action alternative and necessary modifications and repairs will be made.
Operational Criteria for an Industrial Solid Waste Landfill/3745-29-19	Specifies operational requirements for industrial solid waste landfills.	Pertains to any new solid waste landfills to be created onsite and any expansions or modifications of existing landfills during remediation.	ARAR	Will be applied to any activities that involve modification of the closed landfill.
Water/Air Permit Criteria for Decision by the Director/3745-31-05	A permit to install or plans must demonstrate best available technology and shall not interfere with or prevent the attainment or maintenance of applicable ambient air quality standards.	Pertains to any site that will discharge to onsite surface water or will emit contaminants into the air.	ARAR	Alternatives involving onsite water discharge will comply. Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure emissions are within acceptable limits.
Water Quality Criteria for Decision by the Director/3745-32-05	Specifies substantive criteria for section 401 water quality criteria for dredging, filling, obstructing, or altering waters of the state.	Pertains to any site that has or will affect waters of the state.	Not ARAR	Alternatives do not involve dredging, filling, obstructing, or altering waters of the state.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Prohibition of Unauthorized Injection/3745-34-06	Underground Injection is prohibited without authorization from the Director of the Ohio EPA.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	Not ARAR	This is effectively a provision that gives Ohio EPA the authority to enforce state underground injection regulations and permits. Implementation of the substantive provisions of state requirements as ARARs is required by Section 121(d) of CERCLA.
No Movement of Fluid into Underground Drinking Water/3745-34-07	The underground injection of fluid containing any contaminant into an underground source of drinking water is prohibited if the presence of that contaminant may violate primary drinking water standards or otherwise adversely affect the health of persons.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Elimination of Class IV Wells/3745-34-08	The injection of hazardous or radioactive waste directly into an underground source of drinking water is prohibited.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	Not ARAR	None of the alternatives involve injection of hazardous waste.
Requirements for Wells Injecting Hazardous Waste/3745-34-09	Specifies requirements for the injection of hazardous wastes underground. See 3745-34-06 for limitations.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	Not ARAR	None of the alternatives involve injection of hazardous waste.
Waiver of Requirement by Director/ 3745-34-10	The Director of the Ohio EPA may authorize less stringent requirements for an injection that does not occur into, through, or above an underground source of drinking water.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Class V Wells/ 3745-34-13	Specifies requirements for Class V wells. See 3745-34-04 for definitions.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Conditions Applicable to All Permits/3745-34-26	Specifies minimum conditions to be applied to all underground injections.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Mechanical Integrity/3745-34-34	Specifies requirements to be met to ensure mechanical integrity of wells.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Plugging and Abandoning Class I Wells/3745-34-36	Specifies requirements to be met when plugging or abandoning a Class I well. See 3745-34-04 for definitions.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Construction Requirements for Class I Wells/3745-34-37	Specifies construction and siting requirements for Class I wells.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Operating, Monitoring and Reporting Requirements for Class I Wells/3745-34-38	Specifies operating, monitoring, and reporting requirements for Class I wells.	Pertains to sites at which materials are to be injected underground. Consider for technologies such as bioremediation and soil flushing.	ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection will comply with stated regulations.
Petitions to Exclude a Listed Waste at a Facility/3745-50-221 A,B	Allows for petitions to exclude hazardous wastes from a particular facility from the lists in rules 3745-51-30 to 3745-51-31 of the OAC. Also states that Ohio EPA will recognize U.S. EPA's decision to grant or deny such petitions on the Federal level.	Pertains to any site that has wastes that will be delisted by the U.S. EPA. Should Ohio list wastes not addressed by USEPA, this rule would allow Ohio EPA the opportunity to delist these wastes.	Not ARAR	This is effectively an administrative provision allowing for a process to remove a hazardous waste listing designation from a waste. If listed hazardous wastes are generated during remedial activities and if such wastes are believed to no longer to represent a threat to human health or the environment, onsite management standards may be reduced based on concurrence by Ohio EPA and U.S. EPA. Delisting to reduce offsite treatment, storage, or disposal requirements would be accomplished according to applicable federal and state hazardous waste regulations.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Recycling Variances from Classification as a Waste/3745-50-312 A,B,C	Presents criteria by which Director of the Ohio EPA may grant requests from classifying certain materials as a waste.	Pertains to any site that has wastes that may be recycled or reclaimed.	ARAR	Mound Plant will coordinate with Ohio EPA and U.S. EPA if any alternatives involve reclassifying wastes due to recycling/reclamation activities.
Stds and Criteria for Variances from Classification as a Waste/3745-50-312 A,B,C	Presents criteria by which Director of the Ohio EPA may grant requests for variance from classifying certain materials as a waste.	Pertains to any site that has wastes that may be recycled or reclaimed.	Not ARAR	This is effectively an administrative provision allowing for a process to remove a hazardous waste designation from a waste. If hazardous wastes are generated during remedial activities and if such wastes are believed to no longer to represent a threat to human health or the environment, onsite management standards may be reduced based on concurrence by Ohio EPA and U.S. EPA. Pursuit of a variance to reduce offsite treatment, storage, or disposal requirements would be accomplished according to applicable federal and state hazardous waste regulations.
Additional Regulation of Certain Hazardous Waste Recycling Activities/ 3745-50-315 A	Director of the Ohio EPA may regulate hazardous wastes otherwise exempted because of recycling activities as hazardous wastes on a case-by-case basis. The criteria to make this decision are provided by this rule.	Pertains to any site that has hazardous wastes that will be exempted from the hazardous waste rules per OAC 3745-51-06 (Recycling Exemptions).	ARAR	Additional requirements for the management of recyclable materials may be added by Ohio EPA and/or U.S. EPA during the ARARs process.
Permit Information Required for All Hazardous Waste Facilities/3745-50-44 A	Establishes the substantive hazardous waste permit requirements necessary for the Ohio EPA to determine facility compliance. Includes information such as facility description, waste characteristics, equipment descriptions, contingency plan, facility location, topographic map, etc.	Pertains to any site that will have treatment, storage, or disposal of hazardous waste occurring on site, or has existing areas of hazardous waste contamination onsite that will be capped in-place. This, along with other paragraphs of this rule, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Permit Information Required for All Hazardous Waste Land Disposal Facilities/3745-50-44 B	Establishes the substantive hazardous waste land disposal permit requirements necessary for the Ohio EPA to determine adequate protection of the groundwater. Includes information such as groundwater monitoring data, information on interconnected aquifers, plume(s) of contamination, plans and reports on groundwater monitoring program, etc.	Pertains to any facility/site that will have hazardous waste disposed of onsite or has existing areas of hazardous waste contamination onsite that will be capped in-place. This, along with other paragraphs of this rule, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Additional Permit Information: Hazardous Waste Storage in Containers/3745-50-44 C1	Establishes the substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of the container storage. Includes information such as description of containment system, detailed drawings, etc.. See OAC 3745-55-70 through 3745-55-78 for additional container requirements.	Pertains to any site at which storage of hazardous waste onsite will occur in containers. Consider for wastes and contaminated soils that are stored prior to treatment or disposal. This, along with other paragraphs of this rule and OAC 3745-55-70 through 3745-55-78, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Additional Permit Information: Hazardous Waste Storage/Treatment in Tanks/3745-50-44 C2	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of tank treatment and storage units. Includes information such as assessment of structural integrity, detailed plans of tank system(s), description of secondary containment system, etc. See OAC 3745-55-90 through 3745-55-99 for additional requirements.	Pertains to any site at which storage or treatment of hazardous waste in tanks will occur onsite. This, along with other paragraphs of this rule and OAC 3745-55-90 through 3744-55-99, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Additional Permit Information: Hazardous Waste Storage/Treatment in Surface Impoundment/3745-50-44 C3	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of both new surface impoundments and extensions of existing surface impoundments used to store or treat hazardous waste. Includes information such as waste characteristics, detailed plans and reports, information on structural integrity, closure information, etc. See OAC 3745-56-20 through 3745-56-33 for additional surface impoundment requirements.	Pertains to any site at which either a new surface impoundment will be installed or an existing surface impoundment will be expanded. This, along with other paragraphs of this rule and OAC 3745-56-20 through 3745-56-33, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Additional Permit Information: Hazardous Waste Storage/Treatment in Waste Piles/3745-50-44 C4	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of waste piles used to treat or store hazardous waste. Includes information such as waste characteristics, detailed design plans and reports, control of run-on and run-off, closure information, etc. See OAC 3745-56-50 through 3745-56-60 for additional waste pile requirements.	Pertains to sites at which hazardous waste will be stored or treated in waste piles. This, along with other paragraphs of this rule and OAC 3745-56-20 through 3745-56-33, establishes the minimum information required during the remedial design stage. Consider for sites at which stockpiling of wastes and contaminated soils will occur prior to treatment or disposal.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Additional Permit Information: Hazardous Waste Treatment/Disposal by Land Treatment/3745-50-44 C5	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of land treatment to treat or dispose of hazardous wastes. Includes information such as waste characteristics, design measures to maximize treatment, dimensions of treatment zone, design of unit, information on potential crops, etc. See OAC 3745-56-70 through 3745-56-83 for additional land treatment requirements.	Pertains to any site at which land treatment will be used to treat or dispose of hazardous wastes. This, along with other paragraphs of this rule and OAC 3745-56-70 through 3744-56-83, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Additional Permit Information: Environmental Performance Standards/3745-50-44 C6	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of waste piles used to treat or store hazardous waste. Includes information such as waste characteristics, detailed design plans and reports, control run-on and run-off, closure information, etc. See OAC 3745-56-50 through 3745-68-60 for additional waste pile requirements.	Pertains to sites at which hazardous waste will be or have been stored, treated, or disposed of in surface impoundments, waste piles, land treatment units, landfills or underground injection wells. This, along with other paragraphs of this rule and OAC 3745-56-50 through 3745-56-60, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Additional Permit Information: Hazardous Waste Disposal in Landfills/3745-50-44 C7	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of waste piles used to treat or store hazardous waste. Includes information such as waste characteristics, detailed design plans and reports, control run-on and run-off, closure information, etc. See OAC 3745-56-50 through 3745-56-60 for additional waste pile requirements.	Pertains to sites at which hazardous waste will be or have been disposed of in landfills. This, along with other paragraphs of this rule and OAC 3745-56-50 through 3744-56-60, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Additional Permit Information: Hazardous Waste Treatment by Incineration/ 3745-50-44 C8	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of waste piles used to treat or store hazardous waste. Includes information such as waste characteristics, detailed design plans and reports, control of run-on and run-off, closure information, etc. See OAC 3745-56-50 through 3745-56-60 for additional waste pile requirements.	Pertains to sites at which hazardous waste will be treated by incineration. This, along with other paragraphs of this rule and OAC 3745-56-50 through 3744-56-60, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Additional Permit Information: Hazardous Waste Treatment, Storage, and Disposal in Miscellaneous Units/3745-50-44 C9	Establishes substantive hazardous waste permit requirements necessary for the Ohio EPA to determine the adequacy of waste piles used to treat or store hazardous waste. Includes information such as waste characteristics, detailed design plans and reports, control of run-on and run-off, closure information, etc. See OAC 3745-56-60 through 3745-56-60 for additional waste pile requirements.	Pertains to any facility/site at which hazardous waste will be stored, treated, or disposed of in miscellaneous units. This, along with other paragraphs of this rule and OAC 3745-56-50 through 3744-56-50, establishes the minimum information required during the remedial design stage.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Hazardous Waste Facility Permit Conditions/3745-50-58 A,E,H-J	Establishes general permit conditions applied to all hazardous waste facilities in Ohio. Includes conditions such as operation and maintenance, site access, monitoring, etc.	Pertains to all alternatives that will incorporate treatment, storage, or disposal of hazardous waste.	Not ARAR	Such information, where relevant to the CERCLA RI/FS process, is already required by CERCLA.
Trial Burn for Incinerators/3745-50-62 A,B,C,D	Specifies requirements of trial burn.	Pertains to any alternative incorporating onsite incineration.	Not ARAR	None of the alternatives considered involve incineration.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Requirements for Conditionally Exempt Small Quantity Generators/3745-51-05 A-J	Specifies requirements for conditionally exempt small quantity generators of hazardous waste. Provides relief from many hazardous waste regulations.	Consider for sites where the quantity of hazardous waste generated by an onsite action will be less than 100 kg per month. Monthly limit for acute hazardous waste is 1 kg.	Not ARAR	Mound Plant currently generates greater than the maximum amount of hazardous waste for eligibility for conditionally exempt generator status. If the Plant's waste generation decreases in the future, this standard may need to be reevaluated.
Requirements for Recycled Materials/3745-51-06 A,B,C(1)	Defines recycled hazardous wastes and establishes specific exemptions for these wastes from the hazardous waste regulations.	Pertains to any site at which recycling of hazardous wastes may take place. Consider for sites at which the following materials are present: industrial ethyl alcohol, used batteries, used oil, scrap metal, petroleum products, and K087 coal and coke tar sludge.	Not ARAR	Materials subject to these standards are not anticipated to be produced in any of the remedial alternatives. If, however, such wastes are produced, this standard may need to be reevaluated.
Residues of Hazardous Waste in Empty Containers/ 3745-51-07 A,B	Exempts the residues of hazardous wastes from empty containers from the hazardous waste regulations. Provides specific definitions for these residues.	Pertains to any alternative that incorporates storage of hazardous waste onsite in containers.	ARAR	ARAR for any alternative involving containerized hazardous waste.
Evaluation of Wastes/3745-52-11 A-D	Any person generating a waste must determine if that waste is a hazardous waste (either through listing or by characteristic).	Pertains to sites at which wastes of any type (both solid and hazardous) are located.	ARAR	Any materials generated during construction or implementation of remedial actions will be evaluated to determined if it is identifiable as a hazardous waste, or if it is sufficiently similar to a hazardous waste that hazardous waste management standards should be applied.
Hazardous Waste Packaging/3745-52-30	Requires a generator to package hazardous waste in accordance with U.S. DOT regulations for transportation offsite.	Pertains to any site where hazardous waste will be generated by onsite activities and shipped offsite for treatment and/or disposal.	Not ARAR	Not actually an ARAR since applies to containers for offsite shipment. Will be complied with for all alternatives when wastes are to be shipped offsite.
Hazardous Waste Labeling/3745-52-31	Requires packages of hazardous waste to be labeled in accordance with U.S. DOT regulations for offsite transportation.	Pertains to any site where hazardous waste will be generated by onsite activities and shipped offsite for treatment and/or disposal.	Not ARAR	Not actually an ARAR since applies to containers for offsite shipment. Will be complied with for all alternatives when wastes are to be shipped offsite.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Hazardous Waste Marking/3745-52-32	Specifies language for marking packages of hazardous waste prior to offsite transportation.	Pertains to any site where hazardous waste will be generated by onsite activities and shipped offsite for treatment and/or disposal.	Not ARAR	Not actually an ARAR since applies to containers for offsite shipment. Will be complied with for all alternatives when wastes are to be shipped offsite.
Hazardous Waste Placarding/3745-52-33	Generator shall placard hazardous waste prior to offsite transportation.	Pertains to any site where hazardous waste will be generated by onsite activities and shipped offsite for treatment and/or disposal.	Not ARAR	Not actually an ARAR since applies to containers for offsite shipment. Will be complied with for all alternatives when wastes are to be shipped offsite.
Accumulation Time of Hazardous Waste/3745-52-34	Identifies maximum time periods that a generator may accumulate a hazardous waste without being considered an operator of a storage facility. Also establishes standards for management of hazardous wastes by generators.	Pertains to a site where hazardous waste will be generated as a result of remedial activities.	ARAR	Historic disposal of hazardous waste occurred within Operable Unit 1. Although accumulation time limits are somewhat administrative in nature, they do represent reasonable thresholds for upgrading from generator accumulation management standards to permitted facility storage standards for hazardous wastes (or similar wastes) generated during remedial actions.
General Analysis of Hazardous Waste/ 3745-54-13 A	Prior to any treatment, storage, or disposal of hazardous wastes, a representative sample of the waste must be chemically and physically analyzed.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Detailed development of alternatives will include provisions for waste analysis sufficient for selected waste management alternatives.
Security for Hazardous Waste Facilities/3745-54-14 A,B,C	Hazardous waste facilities must be secured to minimize or prohibit unauthorized and unknowing entry .	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.
Inspection Requirements for Hazardous Waste Facilities/3745-54-15 A,C	Hazardous waste facilities must be inspected regularly to detect malfunctions, deteriorations, operational errors, and discharges. Any malfunctions, or deterioration detected shall be remedied expeditiously.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Requirements for Ignitable, Reactive, or Incompatible Hazardous Waste/3745-54-17 A,B,C	Presents general precautions to prevent accidental ignition or reaction of ignitable, reactive, or incompatible wastes.	Pertains to any site at which potentially reactive, ignitable, or incompatible wastes are present.	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.
Design and Operation of Hazardous Waste Facilities/3745-54-31	Hazardous waste facilities must be designed, constructed, maintained, and operated to minimize the possibility of fire, explosion, or unplanned release of hazardous waste or hazardous constituents to the air, soil, or surface water, which could threaten human health or the environment.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.
Required Equipment for Hazardous Waste Facilities/3745-54-32 A,B,C,D	All hazardous waste facilities must be equipped with emergency equipment, such as an alarm system, fire control equipment and a telephone or radio.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.
Testing and Maintenance of Equipment; Hazardous Waste Facilities/ 3745-54-33	All hazardous waste facilities must test and maintain emergency equipment to assure proper operation.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.
Access to Communications or Alarm System; Hazardous Waste Facilities/3745-54-34	Whenever hazardous waste is being handled, all personnel involved shall have immediate access to an internal alarm or emergency communication device.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.
Required Aisle Space at Hazardous Waste Facilities/3745-54-35	Adequate aisle space shall be maintained to allow unobstructed movement of personnel, fire equipment, spill control equipment, and decontamination equipment into any area of the facility operation in the event of an emergency.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of). Consider for sites where wastes will be stored in containers.	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Arrangements/ Agreements with Local Authorities/ 3745-54-37 A,B	Arrangements or agreements with local authorities, such as police, fire department, and emergency response teams, must be made. If local authorities will not cooperate, documentation of that non-cooperation should be provided.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards. Mound Plant currently has a hazardous waste contingency plan for its hazardous waste management activities. This plan is designed to meet regulatory requirements, including arrangements with local authorities. Provisions may need to be added if hazardous waste activities are included as a part of remedial actions at Operable Unit 1.
Content of Contingency Plan; Hazardous Waste Facilities/3745-54-52 A-F	Hazardous waste facilities must have a contingency plan that addresses any unplanned release of hazardous wastes or hazardous constituents into the air, soil, or surface water. This rule establishes the minimum required information of such a plan.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards. Mound Plant currently has a hazardous waste contingency plan for its hazardous waste management activities. This plan is designed to meet regulatory requirements, including arrangements with local authorities. Provisions may need to be added if hazardous waste activities are included as a part of remedial actions at Operable Unit 1.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Copies of Contingency Plan; Hazardous Waste Facilities/3745-54-53 A,B	Copies of the contingency plan required by 3745-54-50 must be maintained at the facility and submitted to all local police departments, fire departments, hospitals, local emergency response teams, and the Ohio EPA.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards. Mound Plant currently has a hazardous waste contingency plan for its hazardous waste management activities. This plan is designed to meet regulatory requirements, including arrangements with local authorities. Provisions may need to be added if hazardous waste activities are included as a part of remedial actions at Operable Unit 1.
Amendment of Contingency Plan; Hazardous Waste Facilities/3745-54-54 A	The contingency plan must be amended if it fails in an emergency, if the facility changes (in its design, construction, maintenance, or operation), or if the list of emergency coordinators or emergency equipment change.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards. Mound Plant currently has a hazardous waste contingency plan for its hazardous waste management activities. This plan is designed to meet regulatory requirements, including arrangements with local authorities. Provisions may need to be added if hazardous waste activities are included as a part of remedial actions at Operable Unit 1.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Emergency Coordinator; Hazardous Waste Facilities/3745-54-55	At all times there should be at least one employee either on the premises or on call to coordinate all emergency response measures.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards. Mound Plant currently has a hazardous waste contingency plan for its hazardous waste management activities. This plan is designed to meet regulatory requirements, including arrangements with local authorities. Provisions may need to be added if hazardous waste activities are included as a part of remedial actions at Operable Unit 1.
Emergency Procedures; Hazardous Waste Facilities/ 3745-54-56 A-I	Specifies the procedures to be followed in the event of an emergency.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been disposed of).	ARAR	Will be applied for all alternatives, except the no-action alternative, where hazardous wastes (or similar wastes) are managed in units for which hazardous waste regulations have standards. Mound Plant currently has a hazardous waste contingency plan for its hazardous waste management activities. This plan is designed to meet regulatory requirements, including arrangements with local authorities. Provisions may need to be added if hazardous waste activities are included as a part of remedial actions at Operable Unit 1.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
General Closure Performance Standard; Hazardous Waste Facilities/3745-55-11 A,B,C	Requires that all hazardous waste facilities be closed in a manner that minimizes the need for further maintenance. Controls, minimizes, eliminates, or prevents post-closure escape of hazardous waste or hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface water or the atmosphere.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been treated, stored, or disposed of).	ARAR	Closure performance standards will be applied for all alternatives involving the use of units for which hazardous waste regulations have standards. In addition, an objective of the implemented remedial actions to achieve the goal set by this standard for historically disposed hazardous waste.
Content of Closure Plan; Hazardous Waste Facilities/3745-55-12 B	Specifies the minimum information required in a closure plan for the Ohio EPA to determine the adequacy of the plan.	Substantive requirements pertain to any site at which hazardous waste is to be treated, stored, or disposed of (or has been treated, stored, or disposed of).	TBC	Preparation of closure plan is an administrative requirement, not a substantive requirement. Technical elements of plan requirements represent good guidance for planning remediation units and will be considered in the development of such plans.
Disposal/ Decontamination of Equipment, Structures and Soils/3745-55-14	Requires that all contaminated equipment, structures, and soils be properly disposed or decontaminated. Removal of hazardous wastes or constituents from a unit may constitute generation of hazardous wastes.	Pertains to any site at which hazardous waste is to be treated, stored, or disposed of (or has been treated, stored, or disposed of).	ARAR	Will be applied to any activities in the alternatives that involves removal/destruction of existing facilities or facilities created during the remedial action.
Post-Closure Care and Use of Property/3745-55-17 B	Specifies the post-closure care requirements, including maintenance, monitoring, and post-closure use of property.	Pertains to all sites with land-based hazardous waste units (landfills and surface impoundments, waste piles, land treatment units, and tanks that meet requirements of landfills after closure), including existing land-based areas of contamination.	ARAR	Will be applied for long term care of wastes left in-place at the close of remedial actions.
Post-Closure Plan/3745-55-18 B	Presents the information necessary for the Ohio EPA to determine the adequacy of a post-closure plan.	Pertains to all sites with land-based hazardous waste units (landfills and surface impoundments, waste piles, land treatment units, and tanks that meet requirements of landfills after closure), including existing land-based areas of contamination.	TBC	Preparation of post-closure plan is an administrative requirement, not a substantive requirement. Technical elements of plan requirements represent good guidance for planning remediation units and will be considered in the development of such plans.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Notice to Local Land Authority/3745-55-19 B	Requires that a record of the type, location, and quantity of hazardous waste disposed of in each unit be submitted to the local land authority and the Director of the Ohio EPA. Also requires that a notation to the deed to the facility property be made indicating that the land was used to manage hazardous wastes and that certain use restrictions may apply to the property.	Pertains to all sites with land-based hazardous waste units (landfills and surface impoundments, waste piles, land treatment units, and tanks that meet requirements of landfills after closure), including existing land-based areas of contamination.	Not ARAR	This is an administrative requirement already addressed by CERCLA.
Condition of Containers/3745-55-71	Containers holding hazardous waste must be maintained in good condition (no rust or structural defects).	Pertains to any site at which hazardous waste will be stored in containers.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.
Compatibility of Waste with Containers/3745-55-72	Hazardous wastes placed in containers must not react with the container material or liner material.	Pertains to any site at which hazardous waste will be stored in containers.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.
Management of Containers/3745-55-73	Containers holding hazardous waste must be closed (except to add or remove waste) and must not be handled in a manner that may rupture the container or cause it to leak.	Pertains to any site at which hazardous waste will be stored in containers.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.
Container Inspections/3745-55-74	Requires at least weekly inspections of container storage areas.	Pertains to any site at which hazardous waste will be stored in containers.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.
Container Storage Area Containment System/3745-55-75 A,B,C,D	Requires that container storage areas have a containment system and specifies the minimum requirements of such a system.	Pertains to any site at which hazardous waste will be stored in containers.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Container Requirements for Ignitable/Reactive Wastes/3745-55-76	Presents general precautions to prevent accidental ignition or reaction of ignitable or reactive wastes that will be stored in containers.	Pertains to any site at which potentially reactive or ignitable wastes are stored, or are to be stored in containers.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.
Container Requirements for Incompatible Wastes/3745-55-77 A,B,C	Presents general precautions when dealing with incompatible wastes.	Pertains to any site at which potentially incompatible wastes are present.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.
Container Closure Requirements/ 3745-55-78	Specifies closure requirements for containers and containment system.	Pertains to any site at which hazardous waste will be stored in containers.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C 3745-52-34.
Assessment of Existing Tank System's Integrity/3745-55-91 A,B,D	Requires that each existing tank used to store or treat hazardous waste that does not have secondary containment be tested to assure tank integrity.	Pertains to any site that has existing hazardous waste treatment or storage tanks that lack secondary containment.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
Design and Installation of New Tank Systems or Components/ 3745-55-92 A-G	Requires a secondary containment system for tanks and assessment to determine tank integrity.	Pertains to any site at which hazardous waste will be either stored or treated in tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
Containment and Detection of Releases for Tank Systems/3745-55-93 A-G,I	Requires secondary containment and leak detection systems for tanks.	Pertains to any site at which hazardous waste will be either stored or treated in tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
General Operating Requirements for Tank Systems/3745-55-94 A,B,C	Specifies general operating requirements for tank systems.	Pertains to any site at which hazardous waste will be either stored or treated in tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Inspections of Tank Systems/3745-55-95 A-D	Requires inspections at least once each operating day.	Pertains to any site at which hazardous waste will be either stored or treated in tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
Response to Leaks or Spills of Tank Systems/3745-55-96 A,B,C,E	Requires that unfit tanks be removed from use and further releases be prevented.	Pertains to any site at which hazardous waste will be either stored or treated in tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
Closure and Post-Closure Care for Tank Systems/3745-55-97 A,B	Specifies closure and post-closure requirements for tank systems.	Pertains to any site at which hazardous waste will be either stored or treated in tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
Tank Requirements for Ignitable/Reactive Wastes/3745-55-98	Presents general precautions to prevent accidental ignition or reaction of ignitable or reactive wastes that are treated or stored in tanks.	Pertains to any site at which potentially reactive or ignitable wastes are stored or treated (or will be stored or treated) in existing tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
Tank Requirements for Incompatible Wastes/3745-55-99 A,B	Presents general precautions when dealing with potentially incompatible wastes that are stored or treated in tanks.	Pertains to any site at which potentially incompatible wastes are stored or treated (or will be stored or treated) in tanks.	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days See comment on O.A.C 3745-52-34.
Design and Operating Requirements: Surface Impoundments/3745-56-21 A-G	Presents design and operating criteria for surface impoundments.	Pertains to any site at which hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites that have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.
Monitoring and Inspection of Surface Impoundments/3745-56-26 A,B,C	Requires inspection of liners during construction. Also requires weekly and after storm inspections.	Pertains to any site at which hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites that have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Emergency Repairs and Contingency Plans; Surface Impoundments/ 3745-56-27 A-E	Specifies when and how surface impoundments should be removed from service for repairs.	Pertains to any site at which hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites that have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.
Closure and Post-Closure of Surface Impoundments/3745-56-28 A,B,C	Provides closure and post-closure requirements for surface impoundments.	Pertains to any site at which hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites which have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.
Surface Impoundment Requirements for Ignitable/Reactive Wastes/3745-56-29 A,B	Presents general precautions when dealing with potentially ignitable or reactive wastes that are stored or treated in surface impoundments.	Pertains to any site at which potentially ignitable or reactive hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites that have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.
Surface Impoundment Requirements for Incompatible Wastes/3745-56-30	Presents general precautions when dealing with potentially incompatible wastes that are stored or treated in surface impoundments.	Pertains to any site at which potentially incompatible hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites that have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.
Construction Inspections of Surface Impoundments/ 3745-56-31 A	Allows the Ohio EPA the opportunity to inspect surface impoundments during construction and installation.	Pertains to any site at which hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites that have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Special Requirements for "F" Wastes in Surface Impoundments/ 3745-56-33 A,B	Prohibits the placement of hazardous wastes F020, F021, F022, F023, F026, and F027 in Surface Impoundments.	Pertains to any site at which hazardous waste will be treated or stored in surface impoundments (lagoons). Pertains to sites that have surface impoundments that will not be (or have not been) clean closed.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a surface impoundment.
Design and Operating Requirements for Waste Piles/ 3745-56-51 A-F	Specifies the design and operation requirements for waste piles. Includes liner system, leachate collection and removal system, wind dispersal, prevention, and run-on/run-off control.	Pertains to any site at which hazardous waste will be stored or treated in waste piles.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a pile.
Monitoring and Inspection of Waste Piles/3745-56-54 A,B	Waste piles must be monitored during construction or installation and operation.	Pertains to any site at which hazardous waste will be stored or treated in waste piles.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a pile.
Waste Pile Requirements for Ignitable/Reactive Wastes/3745-56-56 A,B	Presents general precautions when dealing with potentially ignitable or reactive hazardous wastes that are stored or treated in waste piles.	Pertains to any site at which potentially ignitable or reactive hazardous waste will be stored or treated in waste piles.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a pile.
Waste Pile Requirements for Incompatible Wastes/3745-56-57 A,B,C	Presents general precautions when dealing with potentially incompatible wastes that are stored or treated in waste piles.	Pertains to any site at which potentially incompatible hazardous waste will be stored or treated in waste piles.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a pile.
Closure and Post-Closure Care for Waste Piles/3745-56-58 A,B,C	Specifies closure and post-closure care requirements for waste piles.	Pertains to any site at which hazardous wastes will be stored or treated in waste piles.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a pile.
Construction Inspections for Waste Piles/3745-56-59 A	Allows the Ohio EPA the opportunity to inspect waste piles during construction.	Pertains to any site at which hazardous wastes will be stored or treated in waste piles.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a pile.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Special Requirements for "F" Wastes in Waste Piles/3745-56-60 A,B	Prohibits the placement of hazardous wastes F020, F021, F022, F023, F026, and F027 in waste piles.	Pertains to any site at which hazardous F-wastes will be either stored or treated in waste piles.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a pile.
Land Treatment Program/3745-56-71 A,C	A land treatment program must be designed to ensure that hazardous constituents placed in or on the treatment zone are degraded, transformed, or immobilized within the treatment zone.	Pertains to any site at which hazardous wastes will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Land Treatment Demonstration/ 3745-56-72 A,C	Prior to the actual land treatment program, a demonstration (field or laboratory tests) must be conducted.	Pertains to any site at which hazardous wastes will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Land Treatment Design and Operating Requirements/ 3745-56-73 A-G	A land treatment unit must be designed, constructed, operated, and maintained to maximize degradation, transformation, and immobilization of hazardous constituents in the treatment zone.	Pertains to any site at which hazardous wastes will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Land Treatment Food-Chain Crops/3745-56-76 A-C,G	Food-chain crops may only be grown in or on the treatment zone if allowed by the Director of the Ohio EPA. The criteria for the director to make this decision are provided in this rule.	Pertains to any site at which hazardous wastes will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Land Treatment Unsaturated Zone Monitoring/ 3745-56-78 A-F	An unsaturated zone monitoring program must be established for all land treatment units. The requirements of this program are presented by this rule.	Pertains to any site at which hazardous wastes will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Land Treatment Closure and Post-Closure Care/3745-56-80 A-E	Establishes closure and post-closure requirements for land treatment units.	Pertains to any site at which hazardous wastes will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Land Treatment Requirements; Ignitable/Reactive Waste/3745-56-81 A,B	Prohibits the application of ignitable or reactive waste to the treatment zone, except under certain circumstances.	Pertains to any site at which potentially ignitable or reactive hazardous wastes will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Land Treatment Requirements for Incompatible Wastes/3745-56-82	Prohibits the placement of incompatible waste in or on the treatment zone.	Pertains to any site at which potentially incompatible hazardous waste will be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Special Requirements for "F" Wastes in Land Treatment/3745-56-83 A,B	Prohibits the placement of hazardous wastes F020, F021, F022, F023, F026, and F027 in land treatment units.	Pertains to any site at which hazardous F wastes are to be treated or disposed of in land treatment units.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of land treatment.
Environmental Performance Standards; Land-Based Units/3745-57-01 A-D	Specifies location, design, construction, operation, maintenance and closure requirements for landfills, waste piles, surface impoundments, and underground injection wells.	Pertains to all sites that either have or will have at least one of the following units onsite: landfills, waste piles, surface impoundments, land treatment facilities, and underground injection wells (including existing land-based areas of contamination).	ARAR	Will be applied is alternatives involve any of the prescribed units. Will be applied, as appropriate, for the historic waste disposal site.
Landfill Design and Operating Requirements/ 3745-57-03 A-I	Presents design and operating requirements for landfills. Includes liner, leachate collection and removal, run-on/run-off control, etc.	Pertains to all sites at which a hazardous waste landfill will either be located or an existing landfill will be expanded. This rule pertains to existing land-based areas of contamination.	ARAR	None of the alternatives involve management of hazardous wastes (or similar wastes) in a landfill; however, this standard will be applied, as appropriate, for the historic waste disposal site.
Monitoring and Inspections of Landfills/3745-57-05 A,B	Requires inspection of landfills during construction or installation and operation.	Pertains to all sites at which a hazardous waste landfill will either be located or an existing landfill will be expanded. This rule pertains to existing land-based areas of contamination.	ARAR	None of the alternatives involve management of hazardous wastes (or similar wastes) in a landfill; however, this standard will be applied, as appropriate, for the historic waste disposal site.
Landfill Closure and Post-Closure Care/3745-57-10 A,B	Specifies closure and post-closure requirements for hazardous waste landfills. Includes final cover and maintenance.	Pertains to all sites at which a hazardous waste landfill will either be located or an existing landfill will be expanded. This rule pertains to existing land-based areas of contamination.	ARAR	None of the alternatives involve management of hazardous wastes (or similar wastes) in a landfill; however, this standard will be applied, as appropriate, for the historic waste disposal site.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Landfill Requirements for Ignitable/Reactive Wastes/3745-57-12 A,B	Prohibits the disposal of ignitable or reactive waste in a landfill unless the waste is treated, rendered, or mixed so that the resultant material no longer meets the definition of ignitable or reactive waste.	Pertains to all sites at which potentially ignitable or reactive hazardous waste may be landfilled.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a landfill.
Landfill Requirements for Incompatible Wastes/3745-57-13	Prohibits the disposal of incompatible waste in the same cell of a landfill.	Pertains to all sites at which potentially incompatible hazardous waste may be landfilled.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a landfill.
Landfill Requirements for Bulk and Containerized Liquids/3745-57-14 A-D	The placement of bulk or non-containerized liquid hazardous waste or hazardous wastes containing free liquids (whether or not absorbants have been added) in any landfill is prohibited.	Pertains to all sites at which a liquid hazardous waste or hazardous waste containing free liquids are considered for landfilling.	ARAR	Liquids will not be landfilled during remedial activities.
Landfill Requirements for Containers/ 3745-57-15 A,B	Unless they are very small, containers must either be at least 90% full when placed in the landfill or crushed/shredded prior to placement in the landfill.	Pertains to all sites at which a hazardous waste landfill will either be located or an existing landfill will be expanded and containers are to be disposed of in the landfill.	ARAR	Although no new containers of waste will be introduced during remedial activities, this standard will be applied if containers of hazardous wastes (or similar wastes) are unearthed during remediation and require re-burial.
Disposal of Small Containers of Hazardous Wastes in Overpacks/ 3745-57-16 A-E	Laboratory packs containing hazardous waste may be placed in a landfill if certain requirements are met.	Pertains to all sites at which a hazardous waste landfill will either be located or an existing landfill will be expanded and lab packs are to be placed in the landfill.	ARAR	Although no new labpacks will be introduced during remedial activities, this standard will be applied if labpacks of hazardous wastes (or similar wastes) are unearthed during remediation and require re-burial.
Landfill Construction Inspections/ 3745-57-17 A	Allows the Ohio EPA the opportunity to inspect landfill during construction.	Pertains to all sites at which a hazardous waste landfill will either be located or an existing landfill will be expanded. This rule pertains to existing land-based areas of contamination.	Not ARAR	This is an administrative requirement. Ohio EPA and U.S. EPA inspection authorities have already been established at Mound Plant.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Special Requirements for "F" Wastes in Landfills/3745-57-18 A,B	Prohibits the placement of hazardous wastes F020, F021, F022, F023, F026, and F027 in landfills.	Pertains to all sites at which a hazardous waste landfill will either be located or an existing landfill will be expanded and F wastes are being considered for landfilling.	Not ARAR	None of the alternatives involve onsite management of hazardous wastes (or similar wastes) in a landfill.
Waste Analysis for Incinerators/3745-57-41 A,B	Requires waste analysis be performed for trial burn and for normal operation of incinerator.	Pertains to any alternative that will incorporate incineration of hazardous wastes.	ARAR	Will be applied if onsite treatment of hazardous wastes (or similar wastes) occurs in the form of incineration.
Principal Organic Hazardous Constituents; Incinerators/3745-57-42 A,B,C	Establishes method by which POHCs will be specified.	Pertains to any alternative that will incorporate incineration of hazardous wastes.	Not ARAR	None of the alternatives considered include incineration.
Performance Standards for Incinerators/3745-57-43 A,B,C	Specifies performance standards that all incinerators must meet (destruction removal efficiencies, HCL emissions, and particulate emissions).	Pertains to any alternative that will incorporate incineration of hazardous wastes.	Not ARAR	None of the alternatives considered include incineration.
Incinerator Trial Burns - Alternative Data/3745-57-44 C	Requires trial burn to determine final operating conditions.	Pertains to any alternative that will incorporate incineration of hazardous wastes.	Not ARAR	None of the alternatives considered include incineration.
Incinerator Operating Requirements/3745-57-45 A-F	Specifies general operating requirements for all incinerators.	Pertains to any alternative that will incorporate incineration of hazardous wastes.	Not ARAR	None of the alternatives considered include incineration.
Monitoring and Inspection of Incinerators/3745-57-47 A,B,C	Requires the monitoring of certain parameters on a continuous basis and inspections of equipment.	Pertains to any alternative that will incorporate incineration of hazardous wastes.	Not ARAR	None of the alternatives considered include incineration.
Closure of Incinerators/3745-57-51	Requires that all hazardous waste and hazardous waste residues be removed from the incinerator site.	Pertains to any alternative that will incorporate incineration of hazardous wastes.	Not ARAR	None of the alternatives considered include incineration.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Environmental Performance Standards for Miscellaneous Units/3745-57-91 A,B,C	Establishes location, design, construction, operation, maintenance, and closure requirements for miscellaneous units used to treat, store, or dispose of hazardous wastes.	Pertains to any alternative that incorporates treatment, storage, or disposal of hazardous wastes in miscellaneous units.	ARAR	Will be applied if onsite management of hazardous wastes (or similar wastes) occurs in units other than a container, tank, surface impoundment, pile, land treatment unit, landfill, incinerator, boiler, industrial furnace, or underground injection well.
Monitoring, Inspecting, Analyzing, etc. for Miscellaneous Units/3745-57-92	Requires that monitoring, analysis, inspection, response, reporting, and corrective action be conducted as necessary at miscellaneous units to assure human health and the environment are protected.	Pertains to any alternative that incorporates treatment, storage, or disposal of hazardous wastes in miscellaneous units.	ARAR	Will be applied if onsite management of hazardous wastes (or similar wastes) occurs in units other than a container, tank, surface impoundment, pile, land treatment unit, landfill, incinerator, boiler, industrial furnace, or underground injection well.
Post-Closure Care for Miscellaneous Disposal Units/3745-57-93	Requires post-closure care of miscellaneous units that are disposal units and of treatment or storage of miscellaneous units that leave contaminated soils or groundwater after closure.	Pertains to any alternative that incorporates treatment, storage, or disposal of hazardous wastes in miscellaneous units.	ARAR	Will be applied if onsite management of hazardous wastes (or similar wastes) occurs in units other than a container, tank, surface impoundment, pile, land treatment unit, landfill, incinerator, boiler, industrial furnace, or underground injection well.
Prohibitions: Hazardous Waste Burned for Energy Recovery/3745-58-42 B,C	Describes the types of furnaces, boilers, or cement kilns in which hazardous waste may be burned for energy recovery.	Pertains to any site where hazardous waste has BTU value and may be burned for energy recovery onsite.	Not ARAR	None of the alternatives considered involve burning for energy recovery.
Standards for Generators of Hazardous Waste Fuel/3745-58-43 A,C	Establishes standards for generators of hazardous waste that is used as a fuel or used to produce a fuel. Also establishes standards for generators who are also burners of hazardous waste fuel.	Pertains to any site where hazardous waste has BTU value and may be burned for energy recovery onsite.	Not ARAR	None of the alternatives considered involve burning for energy recovery.
Standards Applicable to Burners of Hazardous Waste Fuel/3745-58-46 A,C,D,E	Specifies the operating requirements for industrial furnaces and boilers that burn hazardous waste fuel.	Pertains to any site where hazardous waste has BTU value and may be burned for energy recovery onsite.	Not ARAR	None of the alternatives considered involve burning for energy recovery.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Prohibitions: Used Oil Burned for Energy Recovery/3745-58-51 B	Describes the types of furnaces, boilers, and space heaters in which used oil may be burned for energy recovery.	Pertains to any site at which "used oil fuel" is onsite and may be burned for energy recovery onsite.	Not ARAR	Used oil will not be burned onsite as part of any of the alternatives.
Standards for Generators of Used Oil Fuel/3745-58-52 A,C	Establishes standards for generators of used oil burned for energy recovery. Also establishes standards for generators of used oil fuel who also burn used oil.	Pertains to any site at which there is used oil that may be burned for energy recovery onsite.	Not ARAR	Used oil is not anticipated to be generated as part of any of the alternatives, nor will it be burned onsite.
Standards for Burners of Used Oil Burned for Energy Recovery/3745-58-54 A,D	Specifies operating requirements for facilities that burn used oil fuel.	Pertains to any site at which there is used oil that may be burned for energy recovery onsite.	Not ARAR	Used oil is not anticipated to be generated as part of any of the alternatives, nor will it be burned onsite.
Recyclable Materials Used for Precious Metals Recovery/3745-58-60 B(2)	Specifies requirements for generators and storers of recyclable materials that are reclaimed to recover precious metals (e.g., gold, silver, platinum, etc.)	Pertains to any site at which there are materials onsite that may be reclaimed for recovery of precious metals.	Not ARAR	Precious metals recovery is not part of any of the alternatives.
Requirements for Reclaiming Spent Lead Acid Batteries/3745-58-70 A,B	Specifies requirements for persons who reclaim spent lead acid batteries and for persons who generate, store, transport, or collect them but do not reclaim them.	Pertains to any site at which there are spent lead acid batteries that may be reclaimed onsite or offsite.	Not ARAR	Lead-acid batteries are not anticipated to be generated as part of any of the alternatives, nor will they be reclaimed onsite.
Ambient Air Quality Standards - Lead/3745-71-02	The ambient air quality standard for lead shall be a maximum arithmetic mean of 1.5 micrograms per cubic meter during any calendar quarter.	Consider for sites where incineration or waste fuel recovery may occur.	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S.EPA and Ohio EPA to ensure lead emissions are within acceptable limits.
Location/Siting of New GW Wells/3745-9-04 A,B	Mandates that groundwater wells be: A) located and maintained so as to prevent contaminants from entering well and B) located so as to be accessible for cleaning and maintenance.	Pertains to all groundwater wells on the site that either will be installed or have been installed since February 1975. Would pertain during the FS if new wells are constructed for treatability studies.	ARAR	Will be applied for new well installation as part of any alternatives.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Construction of New GW Wells/3745-9-05 A1,B-H	Specifies minimum construction requirements for new groundwater wells with regard to casing material, casing depth, potable water, annular spaces, use of drive shoe, openings to allow water entry, and contaminant entry	Pertains to all groundwater wells on the site that either will be installed or have been installed since February 15, 1975. Would pertain during the FS if new wells are constructed for treatability studies.	ARAR	Will be applied for new well installation as part of any alternatives.
Casing Requirements for New GW Wells/3745-9-06 A,B,D,E	Establishes specific requirements for well casings, such as suitable material, diameters, and conditions.	Pertains to all groundwater wells on the site that either will be installed or have been installed since February 15, 1975. Would pertain during the FS if new wells are constructed for treatability studies.	ARAR	Will be applied for new well installation as part of any alternatives.
Surface Design of New GW Wells/3745-9-07 A-F	Establishes specific surface design requirements, such as height above ground, well vents, well pumps, etc.	Pertains to all groundwater wells on the site that either will be installed or have been installed since February 15, 1975. Would pertain during the FS if new wells are constructed for treatability studies.	ARAR	Will be applied for new well installation as part of any alternatives.
Start-up and Operation of GW Wells/3745-9-08 A,C	Requires disinfection of new wells and use of potable water for priming pumps.	Pertains to all groundwater wells on the site that either will be installed or have been installed since February 15, 1975. Would pertain during the FS if new wells are constructed for treatability studies.	ARAR	Will be applied for new well installation as part of any alternatives.
Maintenance and Operation of GW Wells/3745-9-09 A-C,D1,E-G	Establishes specific maintenance and modification requirements for casing, pump, and wells in general.	Pertains to all groundwater wells on the site that either will be installed or have been installed since February 15, 1975. Would pertain during the FS if new wells are constructed for treatability studies.	ARAR	Will be applied for new well installation as part of any alternatives.
Abandonment of Test Holes and GW Wells/3745-9-10 A,B,C	Following completion of use, wells and test holes shall be completely filled with grout or similar material and shall be maintained in compliance of all regulations.	Pertains to all groundwater wells on the site that either will be installed or have been installed since February 15, 1975.	ARAR	Will be applied for new well installation as part of any alternatives.

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Regulation Title or Subject/Revised Code Section and Pertinent Paragraph	Regulation Description	Regulation Application	ARAR	Comments
Use of Wells for Disposal/3745-9-11	No person shall use any well to inject or reinject any substance into the ground without necessary permits.	May pertain to systems that entail injection or reinjection of fluid into the ground. Consider for *in situ* bioremediation, soil flushing, and groundwater plume containment.	Not ARAR	*In-situ* treatment or other activities that might be considered forms of underground injection are not a part of any of the alternatives.

Table 8. Potential Federal Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Capping	Placement of a cap over waste (e.g., closing a landfill, or closing a surface impoundment or waste pile as a landfill, or similar action) requires a cover designed and constructed to:	RCRA hazardous waste placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination will make requirements applicable. Capping without such movement will not make requirement applicable, but technical requirements are likely to be relevant and appropriate.	40 CFR 264.228(a); 40 CFR 264.258(b); 40 CFR 264.310(a)	Not ARAR	Identified alternatives for Operable Unit 1 do not include placement of a cap over waste. However, if remedial action unit construction involves modifying the existing sanitary landfill cap, this standard will be considered (TBC).
	• Provide long-term minimization migration of liquids through the capped area;				
	• Function with minimum maintenance;				
	• Promote drainage and minimize erosion or abrasion of the cover;		40 CFR 264.228(a),		
	• Accommodate settling and subsidence so that the cover's integrity is maintained; and				
	• Have a permeability less than or equal to the permeability of any bottom liner system or natural sub-soils present.				
	• Eliminate free liquids, stabilize wastes before capping (surface impoundments)				
	• Restrict post-closure use of property as necessary to prevent damage to the cover.		40 CFR 264.117(c)		
	• Prevent runon and runoff from damaging cover.				
	• Protect and maintain surveyed benchmarks used to locate waste cells (landfills, waste piles.)		40 CFR 264.228(b) 40 CFR 264.310(b)		
	• Eliminate free liquids by removal or solidification.				
	• Stabilization of remaining waste and waste residues to support cover.		40 CFR 264.228(a)(2)		
	Installation of final cover to provide long-term minimization of infiltration.		40 CFR 264.228(a)(2) and 40 CFR 264.258(b) 40 CFR 264.310		
	Post-closure care and groundwater monitoring				

Table 8. (page 2 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Closure with No Post-closure Care (e.g., Clean Closure)	General performance standard requires elimination of need for further maintenance and control; elimination of post-closure, hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products.	Applicable to land-based unit containing hazardous waste. Applicable to RCRA hazardous waste (listed or characteristic) placed at site after the effective date of the requirements, or placed into another unit. Not applicable to material treated, stored, or disposed only before the effective date of the requirements, or if treated *in-situ*, or consolidated within area of contamination. Designed for cleanup that will not require long-term management. Designed for cleanup to health-based standards.	40 CFR 264.111	ARAR	Closure performance standards will be applied for all alternatives involving the use of units for which hazardous waste regulations have standards. In addition, an objective of the implemented remedial actions will be to achieve the goal set by this standard for historically disposed hazardous waste.
	Disposal of decontamination of equipment, structures, and soils.	May apply to surface impoundments and container or tank liners and hazardous waste residues, and to contaminated soil, including soil from dredging or soil disturbed in the course of drilling or excavation, and returned to land.	40 CFR 264.111 40 CFR 264.178 40 CFR 264.197 40 CFR 264.288(o)(1) and 40 CFR 264.258	ARAR	Will be applied to any activities in the alternatives that involves removal/destruction of existing facilities or facilities created during the remedial action.
	Removal or decontamination of all waste residues, contaminated containment system components (e.g., liners, dikes), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.				
	Meet health-based levels at unit		40 CFR 244.111		

Table 8. (page 3 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Construction of a New Surface Impoundment (See Closure with Waste in Place and Closure with no Post-Closure Care)	Minimum Technology Requirements:	RCRA hazardous waste (listed or characteristic) currently being placed in a new surface impoundment, or use of replacement or lateral extension of existing landfills or surface impoundments.	40 CFR 264.220	Not ARAR	None of the alternatives involve onsite management of wastes in a surface impoundment.
	Use two liner, a top liner that prevents waste migration into the liner and a bottom liner that prevents waste migration through the liner (throughout the post-closure period).				
	Design liners to prevent failure due to pressure gradients, contact with the waste, climatic conditions, and the stress of installation and daily operations.		40 CFR 264.221		
	Provide a leachate collection system between the two liners.		40 CFR 264.221		
	Use a leak detection system that will detect leaks at the earliest possible time.				
	Ground-water Monitoring				
	Establish a detection monitoring program (264.09). Establish a compliance monitoring program (264.99) and corrective action monitoring program (264.100) when required by 40 CFR 264.91. All monitoring programs must meet RCRA general ground-water monitoring requirements (264.97)	Creation of a new landfill unit to treat, store, or dispose of RCRA hazardous wastes as part of a remedial action.	40 CFR 264.221 40 CFR 264.221		

Table 8. (page 4 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Dike Stabilization	Design and operate facility to prevent overtopping due to overfilling: wing and wave action; rainfall; run-on; malfunctions of level controllers, alarms, and other equipment; and human error.	Existing surface impoundment containing hazardous waste, or creation of a new surface impoundment.	40 CFR 264.221	Not ARAR	None of the alternatives involve onsite management of waste in a surface impoundment.
	Construct dikes with sufficient strength to prevent massive failure.		40 CFR 264.221		
	Inspect liners and cover systems during and after construction.		40 CFR 264.226		
	Inspect weekly for proper operation and integrity of the containment devices.		40 CFR 264.226		
	Remove surface impoundment from operation if the dike leaks or there is a sudden drop in liquid level.		40 CFR 264.227 40 CFR 264.228		
	At closure, remove or decontaminate all waste residues and contaminated materials. Otherwise, free liquids must be removed, the remaining wastes stabilized, and the facility closed in the same manner as a landfill.		40 CFR 264.227		
	Manage ignitable or reactive waste so that it is protected from materials or conditions that may cause it to ignite or react.				
Discharge of Treatment System Effluent	Best Available Technology: Use of best available technology (BAT) economically achievable is required to control toxic and nonconventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis.	Point source discharge to waters of the United States.	40 CFR 122.44(a)	ARAR	Alternatives involving discharges to surface waters will comply.

Table 8. (page 5 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Discharge of Treatment System Effluent (cont.)	Water Quality Standards:				Alternatives involving discharges to surface waters will comply.
	Applicable Federally approved State water quality standards must be complied with. These standards may be in addition to or more stringent than other Federal standards under the CWA.		40 CFR 122.44 and State regulations approved under 40 CFR 131		
	Discharge limitation must be established at more stringent levels than technology-based standards for toxic pollutants.		40 CFR 122.44(o)		
	Best Management Practices:				
	Develop and implement a Best Management Practices program to prevent the release of toxic constituents to surface waters.		40 CFR 125.100		
	The Best Management Practices program must: - Establish specific procedures for the control of toxic and hazardous pollutant spills. - Include a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a reasonable potential for equipment failure. - Assure proper management of solid and hazardous waste in accordance with regulations promulgated under RCRA.		40 CFR 125.104		
	Management Requirements:				
	Discharge must be monitored to assure compliance. Discharge will monitor:				

Table 8. (page 6 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Discharge of Treatment System Effluent (cont.)	- The mass of each pollutant - The volume of effluent - Frequency of discharge and other measurements as appropriate		40 CFR 122.41(i)		
	Approved test methods for waste constituent to be monitored must be followed. Detailed requirements for analytical procedures and quality controls are provided.		40 CFR 136.1-136.4		
	Comply with additional substantive conditions such as: - Duty to mitigate any adverse effects of any discharge; and - Proper operation and maintenance of treatment systems.		40 CFR 122.41(i)		
Management Treatment, Disposal of PCBs	Sets standards defining proper management, treatment and disposal of PCB waste.	Materials must meet the definition of PCB, PCB container, PCB article, etc., as provided in 40 CFR Part 761.	40 CFR Part 761	ARAR	Will be applied to any activities that involve PCB-contaminated materials.
Excavation	Placement on or in land outside unit boundary or area of contamination will trigger land disposal requirements and restrictions.		40 CFR 268 (Subpart D)	ARAR	Requirements are applicable for RCRA hazardous waste. Excavated soils will be tested to determine if they exhibit any hazardous waste characteristics and applicable land disposal restrictions will be identified as applicable requirements. According to EPA guidance, the land disposal restrictions will generally not be relevant and appropriate where wastes are not identified as hazardous.
	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268 (Subpart D)		
	Area from which materials are excavated may require cleanup to levels established by closure requirements.	RCRA hazardous waste placed at site after the effective date of the requirements.	See Closure in this exhibit.		

Table 8. (page 7 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Ground-water Diversion	Excavation of soil for construction of slurry wall may trigger closure or land disposal restrictions.	Materials containing RCRA hazardous waste subject to land disposal restrictions are placed into another unit.	See Consolidation in this Exhibit.	ARAR	Requirements are applicable for RCRA hazardous waste. Excavated soils will be tested to determine if they exhibit any hazardous waste characteristics and applicable land disposal restrictions will be identified as applicable requirements. According to EPA guidance, the land disposal restrictions will generally not be relevant and appropriate where wastes are not identified as hazardous.
Treatment or storage in tanks	Tanks must have sufficient shell strength (thickness), and, for closed tanks, pressure controls, to assure that they do not collapse or rupture.	RCRA hazardous waste (listed or characteristic), held in a tank for temporary period before treatment, disposal, or storage elsewhere, (40 CFR 264.10).	40 CFR 264.190	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days. See comment on O.A.C. 3745-52-34.
	Waste must not be incompatible with the tank material unless the tank is protected by a liner or by other means.		40 CFR 264.191		
	New tanks or components must be provided with secondary containment.		40 CFR 264.193		
	Tanks must be provided with controls to prevent overfilling, and sufficient freeboard maintained in open tanks to prevent overtopping by wave action or precipitation.		40 CFR 264.194		
	Inspect the following: overfilling control, control equipment, monitoring data, waste level (for uncovered tanks), tank condition, above-ground portions of tanks, (to assess their structural integrity) and the area surrounding the tank (to identify signs of leakage).		40 CFR 264.195		Will be applied in alternatives involving storage of hazardous waste (or similar waste) in tanks for longer than 90 days. See comment on O.A.C. 3745-52-34.

Table 8. (page 8 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Treatment or storage in tanks (cont.)	Repair any corrosion, crack, or leak.		40 CFR 264.196		
	At closure, remove all hazardous waste and hazardous waste residues from tanks, discharge control equipment and discharge confinement structures.		40 CFR 264.197		
	Store ignitable and reactive waste so as to prevent the waste from igniting or reacting. Ignitable or reactive wastes in covered tanks must comply with buffer zone requirements in "Flammable and Combustible Liquids Code," Tables 2-1 through 2-6 (National Fire Protection Association, 1976 or 1981).		40 CFR 264.198		
	Storage Prohibitions: Storage of banned wastes must be in accordance with 40 CFR 268. When such storage occurs beyond one year, the owner/operator bears the burden of proving that such storage is solely for the purpose of accumulating sufficient quantities to allow for proper recovery, treatment and disposal.		40 CFR 268.50		
Container Storage (onsite)	Containers of hazardous waste must be: • Maintained in good condition. • Compatible with hazardous waste to be stored; and • Closed during storage (except to add or remove waste). Inspect container storage areas weekly for deterioration.	Storage of RCRA hazardous waste (listed or characteristic) not meeting small quantity generator criteria held in a container for a temporary period greater than 90 days before treatment, disposal, or storage elsewhere. A generator who accumulates or stores hazardous waste on site for 90 days or less in compliance with 40 CFR 262.34(a)(1-4); 40 CFR 264.176.	40 CFR 264.171 40 CFR 264.173 40 CFR 264.174 40 CFR 264.175	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C. 3745-52-34.

Table 8. (page 9 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Container Storage (onsite) (cont.)	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10% of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.		40 CFR 264.175	ARAR	Will be applied in alternatives involving storage of hazardous waste (or similar waste) containers for longer than 90 days. See comment on O.A.C. 3745-52-34.
	Keep containers of ignitable or reactive waste at least 50 feet from the facility's property line.		40 CFR 264.176		
	Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier.		40 CFR 264.177		
	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers, liners.		40 CFR 264.178		
	Storage of banned wastes must be in accordance with 40 CFR 268. When such storage occurs beyond one year, the owner/operator bears the burden of proving that such storage is solely for the purpose of accumulating sufficient quantities to allow for proper recovery, treatment, and disposal.				
Clean Closure	General performance standard requires minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products. Disposal or decontamination of equipment, structures,and soils.	RCRA hazardous waste (listed or characteristic) placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination. Not applicable to material undisturbed since November 19, 1980.	40 CFR 264.111;	ARAR	Closure performance standards will be applied for all alternatives involving the use of units for which hazardous waste regulations have standards. In addition, an objective of the implemented remedial actions will be to achieve the goal set by this standard for historically disposed hazardous waste.
	Removal or decontamination of all waste residues, contaminated containment system components (e.g., liners, dikes), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.	May apply to surface impoundment and container or tank liners and hazardous waste residues; contaminated soil, including soil from dredging or soil disturbed in the course of drilling or excavation, and returned to land.	40 CFR 264.111 40 CFR 264.178 40 CFR 264.197 40 CFR 264.228(a)(1) and 40 CFR 264.258		

Table 8. (page 10 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Clean Closure (cont.)	Meet health-based levels at unit.		40 CFR 264.111		
Discharge to Storm Sewers	Requires storm water discharges to be permitted under the Federal (or state) National Pollution Discharge Elimination Systems (NPDES) program. Different requirements are applicable for different classes and types of discharges.	Protection of surface waters against degradation resulting from site discharges	40 CFR 122 40 CFR 125	ARAR	Alternatives involving onsite discharge to sewer systems will comply.
Discharge of Water into Surface Water Bodies	An NPDES permit is required for discharging water offsite into surface water bodies. All surface water discharges must be in compliance with promulgated Ohio Stream Discharge Standards	Protection of surface waters against degradation resulting from site discharges	40 CFR 122 and 40 CFR 125	ARAR	Alternatives involving onsite discharge will comply.
Discharge to Publicly-Owned Treatment Works (POTW) (offsite activity)	Discharge of pollutants that pass through the POTW without treatment, interfere with POTW operation, contaminate POTW sludge, or endanger health/safety of POTW workers is prohibited. • Discharge must comply with local POTW pretreatment program, including POTW specific pollutants, spill prevention program requirements, and reporting and monitoring requirements. • RCRA permit-by-rule requirements (including corrective action where the NPDES permit was issued after Nov. 8, 1984) must be complied with for discharges of RCRA hazardous wastes to POTWs.	Discharge to a POTW. Transport of RCRA hazardous wastes to POTWs by truck, rail, or dedicated pipe (i.e., pipe solely dedicated for hazardous waste [as defined in 40 CFR 264] which discharges from within the boundaries of the CERCLA site to within the boundaries of the POTW).	40 CFR 403.5 40 CFR 270.60(c)	ARAR	Alternatives involving discharge to a POTW will comply.
New Source Performance Standards	Standards for new sources of air emissions. Requirements are source-specific.	Need to determine if these standards apply to potential remedial actions.	CAA Section III	ARAR	Air emissions may be involved as part of the treatment in several of the alternatives. Alternatives involving air emissions will be coordinated with U.S. EPA and Ohio EPA to ensure emissions are within acceptable limits.

Table 8. (page 11 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Waste Treatment	Treatment of restricted hazardous wastes prior to land disposal must attain concentration-based or technology-based treatment standards.	Wastes to be treated must be identifiable as restricted hazardous wastes.	40 CFR 268 (Subpart D)	ARAR	Requirements are applicable for RCRA hazardous waste. Excavated soils will be tested to determine if they exhibit any hazardous waste characteristics and applicable land disposal restrictions will be identified as applicable requirements. According to EPA guidance, the land disposal restrictions will generally not be relevant and appropriate where wastes are not identified as hazardous.
Underground injection of wastes and treated groundwater	UIC program prohibits: • Injection activities that allow movement of contaminants into underground sources of drinking water which may result in violations of MCLs or adversely affects health. • Construction of new Class IV wells, and operation and maintenance of existing wells. Class IV wells are banned except for reinjection of treated groundwater into the same formation from which it was withdrawn, as part of a CERCLA cleanup or RCRA corrective action.	Approved UIC program is required in States listed under SDWA section 1422. (All states have been listed.) Class I wells and Class IV wells are the relevant classifications for CERCLA sites. Class I wells are used in inject hazardous waste beneath the lowermost formation containing, within one quarter mile, an underground source of drinking water (USDW). Class IV wells are used to inject hazardous or radioactive waste into or above the formation which contains, within one quarter mile of the well, an underground source of drinking water.	40 CFR 144.12 40 CFR 144.13	ARAR	Activities that might be considered forms of underground injection will comply with stated regulations.
Closure of Land Treatment Units	Maximize degradation, transformation, or immobilization of hazardous constituents within the treatment zone, minimize runoff of constituents, maintain runon control system and runoff management system, control wind dispersal of hazardous waste, maintain unsaturated zone monitoring, establish vegetative cover, and establish background soil values to determine consistency with permit values.	Closure of land treatment units.	40 CFR 264.280	ARAR	Will be applied if onsite treatment of hazardous waste (or similar waste) occurs in the form of land treatment.

Table 8. (page 12 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Placement of Liquid Waste in Landfill	Liquids in Landfills Prohibition: No bulk or non-containerized liquid hazardous waste or hazardous waste containing free liquids, or solid waste containing free liquid, may be disposed of in landfills. Containers holding free liquids may not be placed in a landfill unless the liquid is mixed with an absorbent or solidified.	Placement of a bulk or non-containerized RCRA hazardous waste or solid waste in a landfill. Placement of containerized RCRA hazardous waste in a landfill.	40 CFR 258.28 40 CFR 264.314 40 CFR 264.314(d)	ARAR	Liquids will not be landfilled during remedial activities.
Placement of Waste In Land Disposal Unit	Land Disposal Restrictions: Attain land disposal "treatment standards" before putting waste into landfill in order to comply with the land ban restrictions. A treatment standard can be either: (1) a concentration level to be achieved (performance-based) or (2) a specified technology that must be used (technology-based). If the standard is performance-based, any technology can be used to achieve the standard. (See Treatment when Waste will be Land Disposal.)	Placement of RCRA hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave.	40 CFR 268 (Subpart D)	ARAR	Requirements are applicable for RCRA hazardous waste. Excavated soils will be tested to determine if they exhibit any hazardous waste characteristics and applicable land disposal restrictions will be identified as applicable requirements. According to EPA guidance, the land disposal restrictions will generally not be relevant and appropriate where wastes are not identified as hazardous.
Slurry Wall	Excavation of soil for construction of slurry wall may trigger land disposal restrictions.	Material containing RCRA hazardous waste subject to land disposal restrictions are placed in another unit. (See Treatment section for LDR schedule. Also see Consolidation, Excavation section in this Exhibit.)	40 CFR 268 (Subpart D)	ARAR	Requirements are applicable for RCRA hazardous waste. Excavated soils will be tested to determine if they exhibit any hazardous waste characteristics and applicable land disposal restrictions will be identified as applicable requirements. According to EPA guidance, the land disposal restrictions will generally not be relevant and appropriate where wastes are not identified as hazardous.

Table 8. (page 13 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Closure with Waste In Place	Eliminate free liquids by removal or solidification. Stabilization of remaining waste and waste residues to support cover. Installation of final cover to provide long-term minimization of infiltration (see Capping). 30-year post-closure care and groundwater monitoring.	Applicable to land disposal of hazardous waste. Applicable to RCRA hazardous waste (listed or characteristic) placed at site after the effective date of the requirements, or placed into another unit. Not applicable to material treated, stored, or disposed only before the effective date of the requirements, or if treated *in situ* or consolidated within area of contamination.	40 CFR 264.228(a)(2) 40 CFR 264.228(a)(2) 40 CFR 264.258(b) 40 CFR 264.310 40 CFR 264.310	ARAR	Closure performance standards will be applied for all alternatives involving the use of units for which hazardous waste regulations have standards. In addition, an objective of the implemented remedial actions will be to achieve the goal set by this standard for historically disposed hazardous waste.
Operation and Maintenance	30-year post-closure care to ensure that site is maintained and monitored.	Land disposal closure.	40 CFR 264.310	ARAR	Closure performance standards will be applied for all alternatives involving the use of units for which hazardous waste regulations have standards. In addition, an objective of the implemented remedial actions will be to achieve the goal set by this standard for historically disposed hazardous waste.
Surface Water Control	Prevent runon and control and collect runoff from a 24-hour, 25-year storm (waste piles, land treatment facilities, landfills).	RCRA hazardous waste treated, stored, or disposed after the effective date of the requirements.	40 CFR 264.251(c), (d) 40 CFR 264.273(c), (d) 40 CFR 264.310(c), (d)	Not ARAR	None of the alternatives involve operation of a landfill cell. If alternatives involve intrusive actions that will cause previously disposed wastes to be exposed, this standard will be reevaluated.
Waste Pile	Use a double-liner and leachate collection system. Waste put into waste pile subject to land disposal restrictions regulations.	RCRA hazardous waste, non-containerized accumulation of solid, nonflammable hazardous waste that is used for treatment or storage.	40 CFR 264.251 40 CFR 268.2, UAC R315-13-1	Not ARAR	None of the alternatives involve onsite management of hazardous waste (or similar wastes) in a pile.

Table 8. (page 14 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Incineration	Analyze the waste feed.	RCRA hazardous waste.	40 CFR 264.341	Not ARAR	None of the alternatives considered involve incineration.
	Dispose of all hazardous waste and residues, including ash, scrubber water, and scrubber sludge.		40 CFR 264.351		
	No further requirements apply to incinerators that only burn wastes that are listed as hazardous soley by virtue of combination with other wastes, and if the waste analysis demonstrates that no Appendix VII constituent is present that might reasonably be expected to be present.		40 CFR 264.340		
	Performance standards for incinerators:	RCRA hazardous wastes.	40 CFR 264.343		
	• Achieve a destruction and removal efficiency of 99.99 percent for each principal organic hazardous constituent in the waste feed and 99.9999 percent for dioxins.		40 CFR 264.342		
	• Reduce hydrogen chloride emissions to 1.8 kg/hr or 1 percent of the HCl in the stack gases corrected for amount of oxygen in stack gas.		40 CFR 264.343		
	• Not release particulate in excess of 180 mg/dscm corrected for amount of oxygen in stack gas.				
	Monitoring of various parameters during operation of the incinerator is required. These parameters include:		40 CFR 264.343	Not ARAR	
	• Combustion temperature.				
	• Waste feed rate.				
	• An indicator of combustion gas velocity.				
	• Carbon monoxide.				
	Control fugitive emissions either by:		40 CFR 264.345		
	• Keeping combustion zone sealed, or				
	• Maintaining combustion zone pressure lower than atmospheric pressure.				

Table 8. (page 15 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Incineration (cont.)	Utilize automatic cutoff system to stop waste feed when operating conditions deviate.				
	Special performance standard for incineration of PCBs: • Achieve a destruction and removal efficiency of 99.9999 percent. • Either 2 second dwell time at 1,200 degrees C° (±100) and 3 percent excess oxygen in stack gas; or 1.5 second dwell time at 1,600 degrees C, and 2 percent excess oxygen in stack gas; and • For non-liquid PCBs, mass air emissions from the incinerator shall be no greater than 0.001 g. KB per kg of the PCBs entering the incinerator.	Liquid and non-liquid PCBs at concentrations of 50 ppm or greater.	40 CFR 761.70	Not ARAR	
Land Treatment	Prior to land treatment, the waste must be treated to BDAT levels or meet a no migration standard.	RCRA hazardous waste being treated or placed into another unit		ARAR	Will be applied if onsite treatment of hazardous waste (or similar waste) occurs in the form of land treatment.
	Ensure that hazardous constituents are degraded, transformed, or immobilized within the treatment zone.		40 CFR 264.271		
	Maximum depth of treatment zone must be no more than 1.5 meters (5 feet) from the initial soil surface and more than 1 meter (3 feet) above the seasonal high water table.		40 CFR 264.271		
	Demonstrate that hazardous constituents for each waste can be completely degraded, transformed, or immobilized in the treatment zone.		40 CFR 264.271		
	Minimize run-off of hazardous constituents.		40 CFR 264.273		
	Maintain run-on\run-off control and management system.		40 CFR 264.273		

Table 8. (page 16 of 16)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Land Treatment (cont.)	Special application conditions if foodchain crops are grown in or on treatment zone.				
	Unsaturated zone monitoring.		40 CFR 264.276		
	Special requirements for ignitable or reactive waste.		40 CFR 264.278		
	Special requirements for incompatible wastes.		40 CFR 264.281		
	Special testing and location requirements for certain hazardous wastes.	RCRA waste #s F020, F021, F022, F026, F027 (dioxin-containing wastes).	40 CFR 264.282		
Construction of New Landfill Onsite (See Closure with Waste in Place)	Minimum Technology Requirements:	RCRA hazardous , Fwaste (listed or characteristic) currently being placed in a new, replacement, or expanded landfill.	40 CFR 264.301	ARAR	Will be applied to any activities that involve modification of the closed sanitary landfill.
	Install two liners or more, a top liner that prevents waste migration into the liner, and a bottom liner that prevents waste migration through the liner.				
	Install leachate collection system above and between the liners.				
	Construct runon and runoff control systems capable of handling the peak discharge of a 25-year storm.				
	Control wind dispersal of particulates.				
	Operation and maintenance.		40 CFR 264.303-304		
	Close each cell with a final cover after the last waste has been received.		40 CFR 264.310		
	Groundwater Monitoring:				
	Establish a detection monitoring program (264.98). Establish a compliance monitoring program (264.99) and corrective action monitoring program (264l100) when required by 40 CFR 264.91. All monitoring programs must meet RCRA general groundwater monitoring requirements (264.97).	Creation of a new landfill unit to treat, store, or dispose of RCRA hazardous wastes as part of a response action.	40 CFR 264.91 - 264.100		Will be applied to any long-term monitoring program.

Table 9. Summary of NPDES Outfall Monitoring Requirements

Monitored Parameter
pH
Total Chlorine
Residual Chlorine
Suspended Solids
Ammonia
BOD
COD
Oil & Grease
Cadmium
Chromium
Copper
Cyanide
Lead
Mercury
Nickel
Zinc
Total Toxic Organics*
Bis(2-ethylhexyl)phthalate
Pentachlorophenol
Fecal Coliform
E. Coliform
Ceriodaphnia dubia
Pimephales promelas

*The organic portion of the priority pollutants list.

Table 10. Constituents and Regulatory Levels for the Toxicity Characteristic

EPA HW No.	Contaminant	Regulatory Limit (ug/L)
D004	Arsenic	5,000
D005	Barium	100,000
D018	Benzene	500
D035	2-Butanone	200,000
D006	Cadmium	1,000
D020	Chlordane	30
D021	Chlorobenzene	100,000
D043	Chloroethene	200
D007	Chromium	5,000
D023	o-Cresol	200,000
D024	m-Cresol	200,000
D025	p-Cresol	200,000
D026	Cresol	200,000
D016	2,4-D	10,000
D027	1,4-Dichlorobenzene	7,500
D028	1,2-Dichloroethane	500
D029	1,1-Dichloroethene	700
D030	2,4-Dinitrotoluene	130[a]
D012	Endrin	20
D031	Heptachlor (and its epoxide)	8
D032	Hexachlorobenzene	130[a]
D033	Hexachlorobutadiene	500
D034	Hexachloroethane	3,000
D008	Lead	5,000
D013	Lindane	400
D009	Mercury	200
D014	Methoxychlor	10,000
D036	Nitrobenzene	2,000
D037	Pentrachlorophenol	100,000
D038	Pyridine	5,000[a]
D010	Selenium	1,000
D011	Silver	5,000
D039	Tetrachloroethene	700
D019	Tetrachloromethane	500
D015	Toxaphene	500
D040	Trichloroethene	500
D022	Trichloromethane	6,000
D041	2,4,5-Trichlorophenol	400,000
D042	2,4,6-Trichlorophenol	2,000
D017	2,4,5-TP (Silvex)	1,000

[a]Quantitation limit is greater than the calculated regulatory level. The quantitation limit, therefore, becomes the regulatory level.

Reference: 40 CFR 261.24.

APPENDIX B

CALCULATIONS FOR ESTIMATING AREA AND VOLUME OF CONTAMINATED MEDIA

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OBJECTIVE B-1
METHOD B-1
NORTH-SOUTH DIMENSION AND VOLUMES B-2
SUMMARY B-4

FIGURES

B.1. Schematic diagram of material types from Cross Section B-1 . . . . . B-5
B.2. Area B east-west cross section B-6

OBJECTIVE:

Estimate volume of potentially contaminated media above the water table.

METHOD:

Estimate areas of each material type in cross-section. Multiply by third dimension (length of Area B, north to south).

Polygon No. (From Cross-Section)	Area (ft^2)	Material Type
1	228 x 5.4 = 1,231	C
2	144 x 10.8 = 1,555	T
3	144 x 14.4 = 2,074	T
4	144 x 0.5 x 8.4 = 605	T
5	36 x 0.5 x 15.6 = 281	T
6	22.8 x 0.5 x 18 = 205	T
7	10.8 x 0.5 x 56 = 302	T
8	60 x 0.5 x 6 = 180	T
9	34 x 0.5 x 4.8 = 82 x 4 = 326	C
10	36 x 0.5 x 7.2 = 130 x 3 = 389	C
11	96 x 18 = 1,730 + 50.4 = 1,780	t
12	44 x 0.5 x 17.4 = 383	t
13	14.4 x 0.5 x 108 = 778	t
14	152 x 0.5 x 14.4 = 1,094	t
15	9.6 x 0.5 x 68 = 326	t
16	46 x 8.4 = 386	t
17	40 x 0.5 x 8.4 = 168	t
18	16 x 10.8 = 173 80 x 0.5 x 10.8 = 432 + 173 = 605	t
19	18 x 0.5 x 120 = 1,080	F
20	76 x 0.5 x 10.8 = 410	t
21	56 x 6 = 336 36 x 0.5 x 6 = 108 + 336 = 444	O
22	88 x 0.5 x 6 = 264	O
23	100 x 0.5 x 6 = 300	t
24	100 x 0.5 x 7.8 = 390	t
25	100 x 0.5 x 7.8 = 390	F
26	100 x 10.2 = 1,020	F
27	100 x 0.5 x 30 = 1,500	F
28	78 x 0.5 x 30 = 1,170	F
29	12 x 0.5 x 4.8 = 28.8 28.8 x 11 = 317	L
30	60 x 3.6 = 216	F
31	80 x 7.2 = 576	F

Polygon No. (From Cross-Section)	Area (ft^2)	Material Type
32	80 x 0.5 x 4.2 = 168	O
33	4.2 x 0.5 x 80 = 168 80 x 9.6 = 768 } 936	t
34	7.2 x 0.5 x 116 = 418 7.8 x 0.5 x 116 = 452 24 x 7.2 = 173 } 1,043	L
35	16 x 0.5 x 6 = 48 x 5 = 240 16 x 3 = 48 6 x 4.2 = 25.2 8 x 0.5 x 4.2 = 16.8 240 + 48 + 25.2 + 16.8 = 330	L
36	240 x 0.5 x 19.2 = 2,304	A

$\sum C$ - 1,946 ft^2

$\sum T$ - 5,202 ft^2

$\sum t$ - 7,556 ft^2

$\sum F$ - 5,952 ft^2

$\sum L$ - 1,690 ft^2

$\sum O$ - 876 ft^2

$\sum A$ - 2,304 ft^2

NORTH-SOUTH DIMENSION AND VOLUMES:

Outwash (O)	Assume representative section. Monitor well 370 has similar outwash thickness. Distance from south road to overflow pond = 300 ft. Estimated total outwash = 876 ft^2 x 300 ft = 262,800 ft^3
Landfill Liner (L)	Assume each side is a slab and base is slab. Assume north and south sides are same thickness as east side. West side (Polygon no. 29): 317 x 150 = 47,550 ft^3 East side (Polygon no. 35): 330 x 150 = 49,500 ft^3 Base (Polygon no. 34): 1,043 x 120 = 125,160 ft^3 Distance between 750 ft contours on landfill = 275 ft (750 topographic contours represent estimated extent of liner) South side: 317 x 275 = 87,175 ft^3 North side: 317 x 275 = 87,175 ft^3 $\sum$ all sides = 396,560 ft^3

NORTH-SOUTH DIMENSION AND VOLUMES: (Continued)

Fill (F)	For north and south sides of landfill, assume wedge of fill beneath each slab. For volume, use average cross sectional areas of wedges beneath north and south sides. East and west sides (from X-section): $5{,}952\ ft^2 \times 175\ ft = 1{,}041{,}600\ ft^3$ Wedge beneath west side (Polygon no. 28): $1{,}170\ ft^2$ Wedge beneath east side (Polygon no. 12): $383\ ft^2$ Average = $777\ ft^2$ Wedge beneath north side: $777 \times 250 = 194{,}125\ ft^3$ Wedge beneath south side: $777 \times 250 = 194{,}125\ ft^3$ Estimated total fill material = $1{,}430{,}000\ ft^3$
Cover (C)	Extends down to 735 ft topographic contour (assumption). Distance between 735 ft contours = 165 ft Estimated total cover material: $1{,}945 \times 165 = 321{,}000\ ft^3$ 1946 (Sheet 2)
Site Sanitary Landfill Trash (T)	Maximum extent in east-west direction is estimated at 740 ft contour. Distance between 740 ft contours = 165 ft Estimated total: $5{,}202 \times 165 = 858{,}300\ ft^3$
Till: (t)	Assume representative cross section. Monitor well 381 similar till thickness. Distance between south road and overflow pond = 300 ft Estimated total: $7{,}556 \times 300 = 2{,}267{,}000\ ft^3$
Aquifer	Area B south of overflow pond. Assume total porosity = 0.30 Total volume = $2{,}304 \times 300 \times 0.30 = 207{,}400\ ft^3$ $\approx 1{,}551{,}000$ gallons

NORTH-SOUTH DIMENSION AND VOLUMES: (Continued)

SUMMARY:

$$\text{Outwash + till} = 262{,}800 + 2{,}267{,}000 = 2{,}530{,}000\ ft^3$$

$$\text{Fill around landfill} = 1{,}430{,}000\ ft^3$$

Landfill:

$$\text{Liner + cover + trash} = 396{,}560 + 321{,}000 + 858{,}300 = 1{,}575{,}860$$
$$\approx 1{,}567{,}000\ ft^3$$

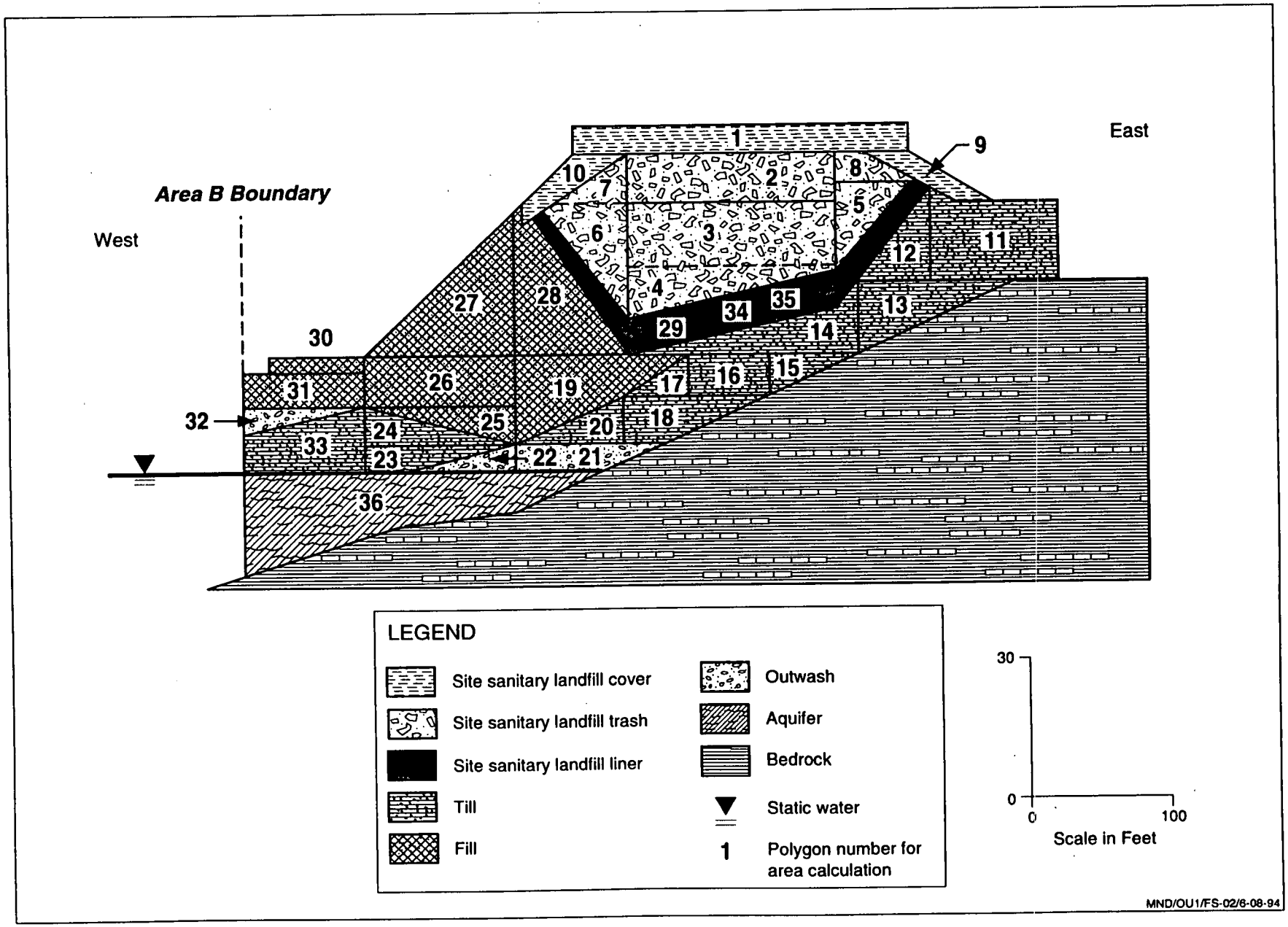

Figure B.1. Schematic diagram of material types from cross section B-1.

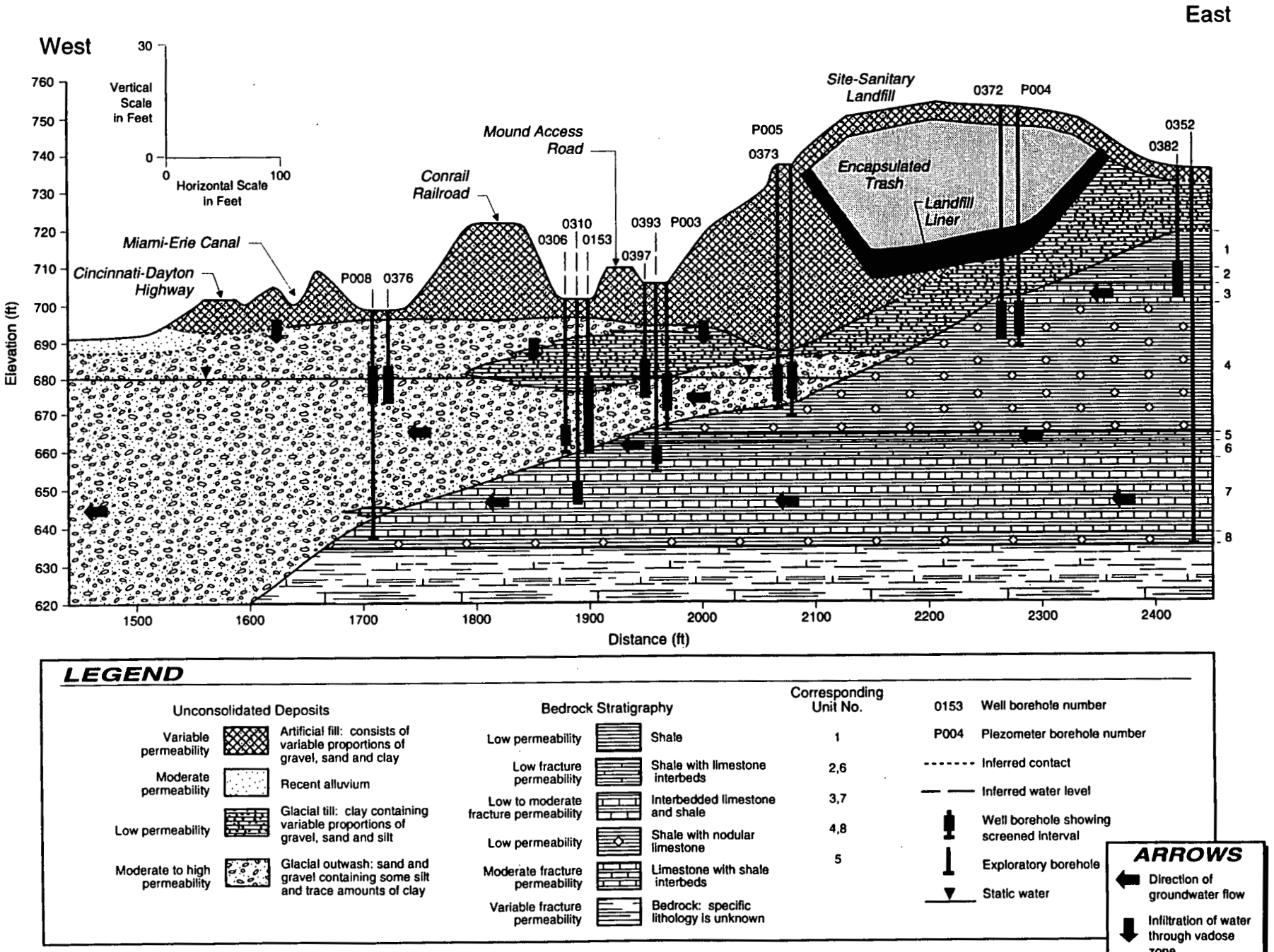

Figure B.2. Area B east-west cross section.

APPENDIX C

GENERAL DESCRIPTION OF PROCESS OPTIONS

C1. PROCESS OPTIONS FOR SOIL MEDIUM

C2. PROCESS OPTIONS FOR GROUNDWATER MEDIUM

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ACRONYMS

ARAR	applicable or relevant and appropriate requirements
FML	flexible membrane liner
GAC	granular activated carbon
NCP	National Contingency Plan
NPDES	National Pollutants Discharge Elimination System
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
UV	ultraviolet
VOC	volatile organic compound

UNITS OF MEASURE

atm	atmosphere
ft	feet
MeV	megaelectron volt
ppm	parts per million

C1. PROCESS OPTIONS FOR SOIL MEDIUM

C1.1. NO ACTION

C1.1.1. No Action

No additional action means no further remedial action would take place at Operable Unit 1. Current contamination would be left in place, and no changes in contaminant levels would be expected except those resulting from natural processes. The no-action option may not achieve remedial objectives; however, it is retained as a basis for comparison with other alternatives and is required by the National Contingency Plan (NCP).

C1.2. INSTITUTIONAL

C1.2.1. Long-Term Monitoring and Access Restriction

Long-term monitoring and access restriction are institutional actions. Future groundwater data would be used to determine if additional contaminants were being leached from the soil medium and contributing to the existing groundwater contamination. Restricted access, such as fencing, creates a physical barrier to prevent human access to Area B.

C1.3. CONTAINMENT

C1.3.1. Capping

C1.3.1.1. Flexible Membrane Liners

A flexible membrane liner (FML) is a thin, continuous sheet of flexible material used to prevent precipitation from infiltrating the area of soil contamination. Infiltration can cause contaminants to be leached from the soil into the groundwater. Materials used to produce FML commonly include polyvinyl chloride, low-density polyethylene, high-density polyethylene, butyl rubber, Hypalon™, and neoprene. Installation can be difficult, and the FML can be damaged by weather, human activity, and animals unless covered by a protective layer.

C1.3.1.2. Low-permeability Soils

Low-permeability soils are placed and compacted to prevent seepage into underlying material; however, soil caps are susceptible to desiccation cracks. An erosion layer on top of the soil liner is usually added

C1.3.1.3. Composite Liners

Composite liners consist of an FML overlying a low-permeable soil liner. A drainage layer and vegetative layer are usually added on top of the FML for drainage and protection.

C1.3.1.4. Surface Sealing

Surface sealing is the placement of a rigid cover to prevent seepage into underlying material. Materials such as a soil admixture, asphalt, or concrete can be used. Rigid materials may potentially crack from differential settling and the freeze/thaw cycle.

C1.3.2. Bottom Sealing

C1.3.2.1. Grout Injection

By injecting grout through a pattern of boreholes drilled in a predetermined depth, a horizontal barrier is constructed below the area of contamination. A horizontal cavity is first formed by jetting at the base of each borehole, and the cavity is then filled with grout. The grout from each borehole intersects to form a horizontal seal.

C1.3.2.2. Block Displacement

Block displacement is used to isolate and raise a contaminated block of earth. A block of contaminated soil is laterally isolated along its perimeter by means of a slurry wall or grout curtain. Grout is horizontally injected at the base of the block through an array of boreholes to complete the bottom seal.

C1.3.3. Surface Controls

Surface control options consist of regrading, revegetation, diversion, collection ditches, and sedimentation basins. Diversion and collection measures use surface management controls to divert surface water runon, enhance surface water runoff, and minimize potential erosion and sediment transport. The primary objective of these process options is to control infiltration into contaminated soils.

C1.4. COLLECTION

C1.4.1. Soil Excavation

Mechanical equipment is used to physically remove soils from beneath the ground surface. Once excavated, the material is ether contained onsite for treatment or disposal or loaded directly into trucks or trailers for transport to an offsite treatment or disposal facility. Excavation may create an airborne contamination problem.

C1.5. TREATMENT

C1.5.1. *In situ*: Bioremediation

Bioremediation is a technique by which contaminated soils are treated in-place through microbial degradation. Naturally occurring microorganisms in the soil are used to degrade hydrocarbon contaminants. Oxygen and nutrients may be added to soil to encourage the microorganisms found in the subsurface to breakdown and detoxify organic compounds. Certain halogenated hydrocarbons may require anaerobic degradation. Reducing conditions, however, would be impractical to maintain in the unsaturated zone.

C1.5.2. *In situ*: Chemical/Physical

C1.5.2.1. Electrical Separation

Electrical separation is a process for the removal of heavy metals, radionuclides, and selected organic pollutants from sand, silts, clays, and sediments. The application of a low intensity direct current across the contaminated soil through in-ground electrodes results in stimulation of the mass transfer mechanisms of advection, diffusion, and ion migration to be stimulated in soil moisture. Removal efficiencies are affected by complex mixtures of heavy metals, radionuclides and organic pollutants as well as heterogeneities in the subsurface. Still in the pilot phase, electrical separation has not been demonstrated 10 feet (ft) below the ground surface.

C1.5.2.2. Detoxification

Detoxification techniques include oxidation/reduction, neutralization, and hydrolysis. Neutralization involves injecting dilute acids or bases into the unsaturated zone groundwater to adjust the pH. The adjustment of the pH is sometimes needed before other *in situ* treatment can begin. Hydrolysis is the

process by which organic compounds undergo a reaction with water, which potentially results in the formation of less toxic by-products. Oxidation/reduction processes cause the degradation of organic contaminants in saturated soil by reaction (change in oxidation state) with oxidants such as ozone or hydrogen peroxide.

C1.5.2.3. Solidification/Stabilization

The solidification/stabilization process involves the fixation, solidification, and stabilization of soil and its contaminants by injecting and mixing chemical agents in the subsurface with multi-axis overlapping hollow-stem augers. This technology immobilizes the contaminants in a monolithic block that can extend down to the treatment depth.

C1.5.2.4. Soil Flushing/Extraction

Soil flushing/extraction is used to mobilize and extract contaminants from soil. Water or aqueous chemical solutions (acids, bases, or chelating agents or surfactants) are injected into the area of contamination and then extracted. The recovered solution is treated and reinjected by way of infiltration galleries or injection wells.

C1.5.2.5. Soil Vapor Extraction

This process removes volatile organic compounds (VOCs) for unsaturated soil. Organic vapors are withdrawn under negative pressure through extraction wells. The soil vapor is then treated to remove contaminants and vented to atmosphere.

C1.5.2.6. Pneumatic Fracturing

Pneumatic fracturing extraction is used to increase subsurface airflow within low permeability formations. This option can be used to enhance contaminant mass removal by using techniques such as soil vapor extraction or hot gas injection. For the latter technique, hot gas is injected under pressure to increase temperatures and volatilize organic contaminants. As with other vapor extraction options, the organic vapors are then extracted, treated (if required), and vented to atmosphere.

C1.5.3. *In situ*: Thermal

C1.5.3.1. Radio Frequency Heating

This process involves desorption of organics from unsaturated soil by electromagnetic energy generated by radio frequency electrodes placed in the ground. As heat is generated, organic contaminants are volatilized. The organic vapors are extracted and treated.

C1.5.3.2. Vitrification

In situ vitrification uses an electric current to melt soil in place at extremely high temperatures into a vitrified glass and crystalline mass. Organic pollutants are destroyed by pyrolysis and inorganic pollutants are incorporated within the solid mass.

C1.5.4. Onsite: Bioremediation

Onsite bioremediation of soils is a process option where soils are excavated and treated with microorganisms to decompose hydrocarbon contaminants. Nutrient concentrations, temperature, and pH are usually controlled to optimize biodegradation. Soils can be remediated through the land farming or composting, or as a slurry using conventional equipment similar to that of activated sludge treatment.

C1.5.5. Onsite: Chemical/Physical

C1.5.5.1. Soil Washing: Water, Acid, and Solvent Extraction

In soil washing, contaminated soil is excavated and screened to remove coarse debris. Water and chemicals such as surfactants, acids, bases, and chelants are added to the soil to produce a slurry. The slurry is fed in batches into mechanical washing equipment, which extracts contaminants from the soil medium. The slurry is dewatered, and the soils can be disposed of or replaced in the original excavation. The solution can be treated and reused.

C1.5.5.2. Dechlorination

Dechlorination involves the removal of chlorine atoms from the chlorinated organic compounds by chemical reaction with a reagent. The result is a compound that is potentially less harmful. Research is being conducted to apply this process to contaminated soils. The soil is washed several times to

complete the process. Soil moisture content can hamper the process, however, and the soil may first require dewatering.

C1.5.5.3. *Solidification/Stabilization*

Solidification/stabilization is a process that immobilizes contaminants in a solid matrix by mixing additives and binders with the soil once it has been excavated. The process can also convert chemical compounds into a more stable form. Contaminants would be immobilized and less prone to leaching. The solidified material can then be disposed of at an offsite facility.

C1.5.6. Onsite: Thermal

C1.5.6.1. Incineration

Incineration is a process option that uses high-temperature oxidation under controlled conditions to thermally destroy organic contaminants. A mobile unit is brought to the site, and excavated soil is fed through the treatment unit. Common examples of incineration techniques include liquid injection, rotary kiln, fluidized bed, wet-air oxidation, and electric infrared systems.

C1.5.6.2. Low-temperature Thermal Desorption

The low-temperature system thermally desorbes organic compounds from contaminated soil without heating the soil to combustion temperatures. The excavated soil is fed through a portable treatment unit where it is heated; and a fan draws desorbed organic vapors through a vapor treatment unit before it is vented from the unit.

C1.5.6.3. UV Photolysis

UV photolysis involves exposure of contaminated soil to ultraviolet radiation, which decomposes organic compounds. This process has used for the destruction of pesticides and dioxins because it is effectively breaks down the carbon-chloride bond. A reactor with UV lamps is used in the treatment process. Soil is fed through the treatment and mix so that it is exposed to the UV light. The process uses vacuum extraction to strip the organic compounds into the vapor phase where the UV light destroys the contaminants.

C1.5.6.4. Vitrification

Vitrification consists of combining contaminated soils with molten glass and cooling the glass to a stable solid. Organic pollutants are destroyed by pyrolysis and inorganic pollutants are encapsulated within the resulting slag, which can then be disposed of properly.

C1.5.6.5. Offsite

The soils are excavated, containerized, and shipped to an appropriate facility for treatment. With this process option, offsite disposal usually occurs as well.

C1.6. DISPOSAL

C1.6.1. Treated Soils: Onsite

C1.6.1.1. New Landfill

A new landfill constructed onsite would serve as a repository for soils once treatment has taken place. Even if the onsite landfill was constructed within the area of contamination in compliance with the required portions of Resource Conservation and Recovery Act (RCRA), other applicable or relevant and appropriate requirements (ARARs) may still be applicable to the onsite disposal of treated soils.

C1.6.2. Treated Soils: Offsite

C1.6.2.1. Offsite landfill

For this process option, treated soils would be disposed of in an approved RCRA landfill facility.

C1.6.3. Untreated Soils: Onsite

C1.6.3.1. New Landfill

A new landfill constructed onsite would serve as a repository for contaminated soils. Even if the onsite landfill is constructed within the area of contamination in compliance with the required portions of RCRA, other ARARs may still be applicable to the onsite disposal of treated soils.

C1.6.4. Untreated Soils: Offsite

C1.6.4.1. Offsite Disposal

For this process option, untreated soils that meet the Land Disposal Restrictions would be disposed of in an approved RCRA landfill facility.

C2. PROCESS OPTIONS FOR GROUNDWATER MEDIUM

C2.1. NO ACTION

C2.1.1. No Action

No action means no further remedial action would take place at Operable Unit 1. Current contamination would be left in place, and no changes in contaminant levels would be expected except those resulting from natural processes. The no-action option may not achieve remedial objectives; however, it is retained as a basis for comparison with other alternatives and is required by the NCP.

C2.2. INSTITUTIONAL

C2.2.1. Monitoring

A long-term groundwater monitoring program would be implemented at Operable Unit 1. Future groundwater data would be used to determine if additional contaminants were migrating away from the area of contamination. This process is retained because it is often incorporated with other options.

C2.2.2. Access Restriction

Restricted access, such as fencing, creates a physical barrier to prevent human access to Area B. This process is retained because it is often incorporated with other options.

C2.3. CONTAINMENT

C2.3.1. Vertical Barriers

C2.3.1.1. Slurry Wall

A slurry wall would be constructed by excavating a vertical trench and simultaneously backfilling it with a slurry. The slurry would be a mixture consisting of soil, bentonite, and water, which helps prevent collapse during excavation and provides a low permeability barrier to control the lateral migration of contaminated groundwater. Maintenance of the slurry wall would be is relatively low compared to other containment technologies such as the pumping well system.

C2.3.1.2. Slurry Columns

Slurry columns form a vertical barrier similar to the slurry wall. Construction of slurry columns involves augering through the subsurface with specialized drilling equipment consisting of a row of closely-spaced augers suspended from a crane. As the augers advance to the desired depth, bentonite would be added through the center of the augers and is mixed with the soil being penetrated. The soil would be mixed again as the augers are withdrawn, and a low permeability barrier would be formed.

C2.3.1.3. Sealable Sheet Piling

Sealable sheet piling is a type of vertical barrier developed at the University of Waterloo's Institute for groundwater research. The steel sheet piling would be driven into the ground using conventional installation methods, and the joints would interlock to form a cavity. The cavity would be inspected and filled with a sealant to form an impermeable barrier.

C2.3.1.4. Grout Curtain

Grout curtains would be constructed by injecting grout through tubes temporarily placed in predrilled boreholes. The boreholes would be located along three successive rows to prevent "windows" in the grout curtain. Grout shrinkage and nonoverlapping grout injections are associated problems that may leave open areas or gaps in the curtain. Such gaps in the curtain would affect the curtains ability to contain groundwater.

C2.3.2. Hydraulic Barriers

C2.3.2.1. Pumping Well System

A pumping well system could be used to form a hydraulic barrier by manipulating the groundwater flow direction and gradient. The radius of influence created by a network of wells could be used to control the groundwater flow regime and capture or redirect water that would normally flow away from areas of contamination. Wells used primarily for groundwater extraction could also cause a hydraulic barrier to form as a result of pumping. The barrier would be considered temporary because it exists only while the pumping system is operating.

C2.3.2.2. Trench Collection System

A trench collection system would use subsurface drains to intercept groundwater. Within the system, sumps equipped with pumps would be used for extraction of the collected groundwater. Conventional dewatering techniques used during trench installation would be effective only to depths of 20 ft. During operation, the trench collection system acts as a continuous line of pumping wells and forms a hydraulic barrier. A hydraulic barrier would only be formed as a result of continuous pumping.

C2.4. COLLECTION

C2.4.1. Vertical Systems

C2.4.1.1. Pumping Well System

Groundwater collection and extraction using a pumping well system would require a series of wells to be installed at the site. Each well would be individually equipped with dedicated pumps. The combined influence of the wells would intercept the flow of contaminated groundwater within the defined capture zone. Groundwater flow direction and withdrawal rates would be controlled by the well pumps. Groundwater pumped to the surface would then be treated or disposed of properly.

C2.4.1.2. Well Point System

An alternative to pumping wells for groundwater collection and extraction is the installation of well points. Groundwater would be removed from the subsurface through closely spaced well points connected by a main suction header instead of wells with individual pumps. Well points, however, are best suited to shallow aquifers where total lift of water is not greater than about 20 ft. Total lift required at the Site may exceed the 20-ft limit.

C2.4.2. Horizontal Systems

C2.4.2.1. Trench Collection System

A trench collection system is a subsurface drain system used to collect and extract groundwater. The system includes sumps and lift pumps to extract the collected water from below the ground surface. This type of extraction system acts as a continuous line of pumping wells and is a proven and reliable technology that can provide the control needed to effectively capture groundwater. Dewatering is

required for some types of trench installation. The conventional dewatering technique for trench installation uses well points that are effective only to depths of 20 ft.

C2.4.2.2. Horizontal Well System

Horizontally oriented extraction wells could be used to collect contaminated groundwater. Horizontal wells have been successfully drilled and completed in unconsolidated sediments using short-radius, mud-rotary drilling tools. The overall drilling performance would be controlled by geologic conditions (percentage of fines), rigid drill mandrel configuration, drilling bit speed and weight, and drilling fluid pumping rates. Preferred target zones for optimal drilling performance would contain minor amounts of clay, which improves the competency of the formation. In addition, downhole surveys would be required during the drilling process to record the direction and angle of the borehole.

C2.5. TREATMENT

C2.5.1. *In situ*: Physical/Chemical

C2.5.1.1. Geochemical Fixation

Inorganic contaminants including heavy metals and radionuclides could be removed from groundwater and fixed onto aquifer material through the process of geochemical fixation. In a pump-and-treat alternative, pumped water would be chemically modified and reinjected to change existing pH and oxidation/reduction conditions and optimize geochemical interactions between the contaminant and the aquifer material. The geochemical reactions of sorption, precipitation and ion-exchange would decrease the concentrations of inorganics in the groundwater.

C2.5.1.2. Chemical Injection

In situ chemical injection involves the subsurface injection of surfactant solutions to groundwater systems contaminated with non-aqueous phase liquids. The solutions increase the effective solubility of organic contaminants by two or three orders of magnitude. Extraction wells would recover the injected surfactant for treatment and reuse. The contaminated groundwater, however, must be contained within a "treatment zone" to ensure that the injected reagents do not migrate and unintentionally affect other areas. The effect of the injected chemicals and their reaction products on the site must also be considered.

C2.5.1.3. Permeable Treatment Walls

Treatment walls are trenches excavated perpendicular to the groundwater flow direction and backfilled with a reactor material. The permeable material would treat contaminated groundwater as it flowed through the trench. The treatment materials could include an iron-based reactor material, limestone, carbon, or glauconite. The limestone and glauconite treatment materials would be for removal of heavy metals. The iron-based reactor material and carbon material would be used for removal of organic contaminants. Limitations of this process include saturation or plugging of the treatment material.

C2.5.1.4. Polymer Sponge

The polymer sponge technology utilizes open-cell cellulose sponges impregnated with an amine-containing polymer. The polymer has a selective affinity for metal cations and anions dissolved in water. The technology would be employed by packing the sponges into nets that would then be suspended in contact with groundwater in wells. The nets are removed when saturated. This technology has been effective in removing trace heavy metals from acid mine drainage at three locations in Colorado. A major limitation of the polymer sponge technology is that it is designed only to remove heavy metals.

C2.5.1.5. Hydrolysis

Hydrolysis is the use of water to destroy, decompose, or alter a organic chemical contaminant to render it less toxic. The rate of hydrolysis and formation of end products is strongly influenced by the pH of the water being treated. This technology is rarely used for *in situ* applications because it is difficult to predict the by-product formation, and very sensitive process controls are required.

C2.5.1.6. Oxidation

Organic compounds in groundwater could potentially be degraded *in situ* by reaction with oxidants like ozone or hydrogen peroxide. The oxidants would be either injected into the groundwater through wells or infiltrated into the groundwater through subsurface trenches. *In situ* oxidation is limited in application because it is difficult to monitor and to control by-product formation. Hence, *ex situ* (onsite) oxidation is more applicable.

C2.5.1.7. Air Sparging

Air sparging involves forcing air into the aquifer, causing volatilization of VOCs. The air sparging system consists of an array of injection and extraction wells. Extraction wells would be located above the water table. Vacuum pumps would be used to extract contaminant vapors through the extraction wells. The injection wells would be located below the water table to facilitate air movement through the contaminated groundwater and enhance bioremediation by providing oxygen.

C2.5.2. *In situ*: Bioremediation

C2.5.2.1. Enhanced Bioremediation

In situ, enhanced bioremediation uses microorganisms to destroy organic contamination in the subsurface environment. Microorganisms would be either naturally occurring, specially adapted, or genetically engineered. The microbial population is usually enhanced and controlled with the injection of oxygen and nutrients. Its success requires the integration of the hydrology, chemistry, and microbiology of the site. This process option requires more time than some of the physical/chemical technologies. Also, the performance of this process option may be reduced for heavily chlorinated organics such as those encountered at Operable Unit 1.

C2.5.2.2. TreeMediation™

TreeMediation™ uses trees and vegetation to pump out groundwater and treat contaminants in soil and water through natural biochemical processes. It can be used to reduce the concentration of many contaminants through absorption and assimilation or degradation. A large number of trees would be planted in close proximity over the contaminated aquifer. The tress would then simulate a large number of very small wells that could draw water upward through the contaminated soil columns, thereby cleaning the soil in the process. TreeMediation has been used to remediate aquifers up to 20 ft deep.

C2.5.3. Onsite: Physical/Chemical

C2.5.3.1. Air Stripping With Vapor Phase Treatment

Air stripping is a mass transfer process whereby volatile contaminants are removed from liquids, such as groundwater, by forcing high-pressure air through the liquid. Air stripping is commonly performed onsite using a packed tower that works on the principle of countercurrent flow. The contaminated

water would flow downward through the packing while the air would flow upward and would be exhausted through the top. Other types of air strippers include the low profile tray and multi-cell air stripper. These units diffuse air through a chamber of flowing water to achieve the mass transfer process. Because volatile contaminants are transferred from the liquid phase to the gaseous phase and then vented from the air stripping unit, emission control devices may be required to first remove the contaminants from the airstream. To comply with applicable regulations, an emission controls device may be required. Air emission control devices include a vapor-phase granular activated carbon (GAC) and a catalytic oxidizer. It is not effective for vinyl chloride or inorganics and may require pH adjustment of H_2S, phenol, ammonia, and other organic acids or bases to reduce solubility and improve transfer to the gas phase. The influent may have to be pretreated to remove iron and magnesium present in the groundwater.

C2.5.3.2. Steam Stripping

Steam stripping is used to remove VOCs from water or aqueous streams. The steam stripping technology is similar to the air stripping technology, except that steam stripping uses steam as the gas phase. Compounds with relatively low volatility or high water solubility are not readily air-strippable, but can often be removed with steam stripping. As with air stripping, the volatile contaminants would be transferred from the liquid phase to the vapor phase, leaving a treated bottom product of clean water, and a vapor that is condensed and collected. The condensed vapor product is a concentrated aqueous solution that may be treated further or recycled. However, noncondensing organics like vinyl chloride will be vented to the atmosphere. Therefore, a vapor phase treatment system like that proposed for the air stripping treatment would be required.

C2.5.3.3. Cascade Aerator

Originally used as an effective means of oxygenating large flows of wastewater, this process option is also used for the removal of VOCs from groundwater. It is a simple and very low cost process option. The groundwater is pumped to the top of an inclined plane, where it cascades by gravity down a transversely corrugated surface. The resulting turbulence enhances the mass exchange of dissolved VOCs from the water to the gas phase. Desorption coefficients (overall mass transfer) are generally one order of magnitude larger than those reported for packed columns. Tests show rates greater than 99 percent are possible with reasonable treatment surface lengths and angles of inclination. One disadvantage was that the same tests showed cascade aeration was only partially effective for removing soluble chemicals with a Henry's law constant of less than 50 atmospheres.

Pretreatment of the water to remove inorganics, such as iron and magnesium, are not needed. This system can also be fitted with a vapor phase treatment system, if needed, like that described for the air stripping treatment unit.

C2.5.3.4. Vacuum Degasification

Currently vacuum degasification is a technology still in theoretical development. The objective of this technology is to reduce the vapor pressure in soil, causing VOCs to change phase from liquid to gas, which would then be extracted. This technology is similar to vapor extraction, is primarily implemented in the unsaturated zone, and is most effective for compounds with low Henry's Law constants.

C2.5.3.5. Thin-Film Evaporation

Thin-film evaporators are used to remove or recover organic components from liquid or sludge waste streams. For mixed (water and organics) waste streams, a thin-film evaporator would selectively remove the water to improve the heat content of the treated bottom waste so that it is more easily incinerated. The evaporator could also selectively remove the organics so that they can be recycled or burned. Thin-film evaporators do not work well with extremely viscous materials or with wastes that react immediately when heated. Thin film evaporators are appropriate for sludges or viscous liquids.

C2.5.3.6. Electrochemical Heavy Metal Immobilization

The electrochemical, *in situ*, chromate reduction and heavy metal immobilization process uses electrochemical reactions to generate ions for removal of hexavalent chromium and other metals from groundwater. Groundwater would be pumped through the treatment unit and an electrical current passed from electrode to electrode through the process water. The electrical exchange would induce the release of ferrous and hydroxyl ions from opposite sides of each electrode and cause the reduction of hexavalent chromium to occur. The resulting solids that may form would include chromium hydroxide, hydrous ferric oxide, and a chromium-substituted hydrous iron complex. The treatment system is designed to treat groundwater contaminated with hexavalent chromium and other heavy metals including zinc, copper, nickel lead, and antimony.

C2.5.3.7. High-Energy Electron Beam

This technology uses a high-energy electron beam, created by a 1.5 magaelectron volt electron accelerator to destroy hazardous constituents in groundwater. The electrons would pass through a

thin window and strike contaminated water that falls from a weir. The weir causes the water to form into a thin sheet before being irradiated. The beam would ionize the water and form hydroxyl radicals, aqueous electrons, and hydrogen radicals, all of which would decompose the organic compounds and bacteria in the water. The high-energy electron beam is best suited for destruction of halogenated hydrocarbons.

C2.5.3.8. UV/oxidation

UV/oxidation treatment involves the use of ozone, or hydrogen peroxide and ultraviolet light to photo-oxidize organic contaminants. Groundwater would be pumped into holding tanks and hydrogen peroxide added to begin destruction of the organics. Ozone would be generated in the UV/oxidation tanks. Ultimately, the VOCs would be destroyed, resulting in carbon dioxide, water, and halide ions. Unreacted contaminants or partially oxidized residuals in the aqueous effluent may require additional treatment. During this process, the system would provide emission control for generated hydrogen chloride.

C2.5.3.9. Chemical Oxidation/Reduction

In chemical oxidation and reduction technologies, chemical transformation of reactants occurs, and the contaminants are destroyed by oxidation or their toxicity is lowered by raising the oxidation state of one reactant while reducing that of another. Oxidation treatment could be used for benzene and most organics, phenols, cyanide, arsenic, iron, and manganese. Reduction treatment could be used for chromium (VI), lead, silver, and chlorinated organics such as polychlorinated biphenyl (PCBs). In some cases, undesirable by-products may be formed as a result of oxidation/reduction.

C2.5.3.10. Granular Activated Carbon Adsorption

GAC adsorption is a treatment process that is widely used, effective, and easily implemented for the treatment of a wide range of organic groundwater contaminants. Adsorption is a surface phenomenon in which soluble molecules from a solution are bonded onto a carbon surface. Once the carbon surface is saturated with contaminants, the carbon material is replaced, and the saturated carbon is regenerated or incinerated. The useful life of the carbon depends upon the specific contaminants, contaminant mass flow rate, and effluent contaminant concentrations. The useful life of the carbon could be extended by pretreatment of the groundwater before passing it through the carbon filters.

C2.5.3.11. Resin Adsorption

Resin adsorption is used for the removal of organic contaminants from aqueous waste streams. Similar to carbon adsorption, organic molecules contacting the resin surface would be held on the surface by physical forces and subsequently removed during the resin regeneration cycle. The type of resin used would be tailored specifically for the COC.

C2.5.3.12. Membrane Microfiltration

The membrane microfiltration technology is an above-ground treatment system designed to remove solid particles from liquid wastes and from filter cakes typically ranging from 40 to 60% solids. This technology is best suited for treating contaminated groundwater with total dissolved solids of less than 5000 ppm and may be applied to heavy metals, landfill leachate, volatile organics, and oily wastes. A pilot demonstration has been conducted in which the system treated heavy metal contaminants in groundwater.

C2.5.3.13. Ion Exchange

Ion exchange is a process that reversibly exchanges ions in solutions with ions retained on a reactive solid material called the ion exchange resin. Because the reaction is reversible, it is possible to regenerate the ion exchange resin. This process option is used mostly for metals and inorganics.

C2.5.3.14. Reverse Osmosis

Reverse osmosis is a physicochemical process that involves flow from a dilute solution through a semipermeable membrane to a more concentrated solution. The application of pressure to the concentrated solution to overcome the osmotic pressure would force the net flow of water through the membrane toward the dilute phase. As the water flows through the membrane, the larger organic and inorganic compounds would be rejected. This process can reduce concentrations of dissolved organic and inorganic solids in groundwater, but extensive pretreatment is often required, and the equipment is subject to fouling and plugging. The resulting concentrated residuals would contain hazardous constituents.

C2.5.3.15. Distillation

Distillation is a process option that separates components of a liquid or sludge mixture by partially vaporizing the mixture and separately recovering the vapors. This process option is very useful for

reclaiming spent solvent from industrial processes such as acetone, alcohol, chlorinated organics, hydrocarbons, and ketones. It is not for treatment of polyurethanes or inorganics. The process is feed-sensitive and may not be suited for highly variable waste streams; therefore, this system has limited applications in the treatment of CERCLA wastes.

C2.5.3.16. Dechlorination

Dechlorination is a process in which chlorine is chemically removed from chlorinated organic compounds, such PCBs and dioxins. It is mainly used for dechlorination of transformer fluids. By-products include salts, polymers, and heavy metals.

C2.5.3.17. Chlorinolysis

Chlorinolysis is a process which chemically converts most chlorinated organic compounds to carbon tetrachloride. This process takes place at 500° C and 200 atmospheres (atm) of pressure. The ensuing distillation yields carbon tetrachloride. Chlorinolysis can be used with liquids, emulsions, and slurries. Waste products of this process include hydrochloric acid and phosgene gas.

C2.5.4. Onsite: Thermal

C2.5.4.1. *Liquid Injection Incinerator*

A liquid incineration system consist of a single or double refractory-lined combustion chamber and a series of atomizing nozzles. The liquid waste would be converted to a gas before combustion. Liquid injection incineration would be operated at high temperatures and used to destroy various types of pumpable waste or gas such as PCBs, solvents, polymer wastes, and pesticides.

C2.5.4.2. Plasma Arc

This process option is used for the destruction of organic contaminants in liquids. It is an pyrolysis process that involves breaking the bonds between organic constituents. Thermal decomposition occurs when wastes are heated in an oxygen deficient atmosphere. An atomization zone would be created when co-linear electrodes generate the electric arc (plasma). The electrical energy would be converted to thermal energy as low-pressure air passes through the arc. Intense ultraviolet light would be emitted when the plasma is allowed to decay, reducing atomized waste material to their elemental constituents to form nonhazardous molecules.

C2.5.4.3. Wet-Air Oxidation

Wet air oxidation involves aqueous-phase oxidation of dissolved or suspended organic substances at elevated temperatures and pressures. The waste would be pumped into the system by high pressure and mixed with air. The mixture would then pass through a heat exchanger and into a reactor where oxygen in the air would react with the organic matter in the waste. This process option is used primarily to treat concentrated waste streams containing organic and oxidizable inorganic wastes.

C2.5.5. Onsite: Biological

C2.5.5.1. Conventional Biological Methods

Onsite biological treatment processes use conventional, aboveground biological methods to remove organic contaminants from groundwater through microbial degradation. These conventional biological methods include aerobic and anaerobic processes. Aerobic biological treatment consists of activated sludge processes, rotating biological contactors, and trickling filters. The anaerobic process uses a digester. All processes are performed aboveground. The microorganisms in the aerobic and anaerobic processes would require both carbon and energy sources. The objective is for the contaminants present in the groundwater to provide these sources for sustained biological growth. If aerobic organisms are used in the treatment process, then an oxygen source would also be required. Treatability studies would be required to determine optimal conditions, and the microorganisms used in the treatment process would have to be acclimated. The sludge that accumulates within the biological process units would also requires disposal.

C2.5.6. Pretreatment

C2.5.6.1. Precipitation/Flocculation With Sedimentation

Chemical precipitation/flocculation is a physicochemical process in which a dissolved constituent is transformed into an insoluble solid, facilitating its subsequent removal from the liquid phase by sedimentation or filtration. The process usually involves (1) adjustment of pH to shift the chemical equilibrium to a point that no longer favors solubility, (2) addition of a chemical precipitant, or (3) flocculation in which precipitate particles agglomerate into larger particles. The residuals may contain hazardous constituents and would require disposal according to RCRA and solid waste regulations.

C2.5.6.2. Neutralization

Neutralization consists of adding acid or base to a waste in order to adjust the pH. It is used as a pretreatment for several chemical treatment technologies, including carbon adsorption, ion exchange, air stripping, wet air oxidation and chemical oxidation/reduction processes.

C2.5.6.3. Filtration

Filtration is a process whereby suspended solids are removed from solution by forcing the fluid through a porous medium. Filters are often preceded by sedimentation basins. The filter media is usually a granular material, such as sand, and would be contained within a tank equipped with an underdrain system. The liquid to be filtered would be drawn through the media and then removed through the underdrain while the filter media remained in place trapping particles. The media would be periodically flooded or backwashed to remove the trapped particles. The residuals may contain hazardous constituents and would require disposal according to RCRA and solid waste regulations.

C2.5.7. Offsite

C2.5.7.1. Offsite Facility

Under this process option, contaminated groundwater would be containerized and transported to an approved treatment facility. The treated water would be disposed of at an approved facility.

C2.6. DISPOSAL

C2.6.1. Onsite: Untreated Groundwater

C2.6.1.1. Evaporation Pond

An evaporation pond is an above-grade surface impoundment designed for total retention of untreated groundwater. The pond would be lined with a geosynthetic membrane or a layer of compacted clay soils to prevent seepage into the subsurface. The effectiveness of an evaporation pond as a disposal technology is dependant upon meteorological conditions such as the annual precipitation rate and the pan evaporation rates at the site. It is unlikely that evaporation rates at the site would be consistently high enough throughout the year for this technology to be effective.

C2.6.1.2. Deep Well Injection

Under this option, a deep well for untreated liquid waste injection would be drilled and completed in a water-bearing, hydrogeologic formation hydraulically confined by overlying and underlying impermeable formations. The formation receiving the waste must be sufficiently thick, permeable, and extensive to prevent migration of the injected waste into adjacent formations or aquifers.

C2.6.2. Onsite: Treated Groundwater

C2.6.2.1. Shallow-Well Injection

Shallow-well injection consists of wells completed in the upper portion of the aquifer for the injection of treated groundwater. Shallow-well injection would recharge the surficial aquifer, which may enhance the efficiency of groundwater collection systems such as the pumping well system. An additional benefit is that a hydraulic barrier would be formed. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, would not be desirable to reinject the treated groundwater into the surficial aquifer.

C2.6.2.2. Infiltration Gallery

An infiltration gallery consists of a trench designed to recharge the surficial aquifer. A trench would be excavated and the base backfilled with coarse sand or gravel to increase infiltration rates. A benefit of this technology is a hydraulic barrier that would be formed, which can redirect groundwater flow. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, it would not be desirable to discharge treated groundwater into the surficial aquifer.

C2.6.2.3. Subsurface Irrigation

A subsurface irrigation system for the disposal of treated groundwater is designed and operated much like a conventional wastewater leachfield. Long lengths of perforated pipes would be installed in closely spaced, shallow trenches. The base of the trenches would be partially backfilled with gravel before the pipes were installed to increase infiltration rates. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, would not be desirable to discharge treated groundwater into the surficial aquifer.

C2.6.2.4. Surface Irrigation

A surface irrigation system consists of a network of evenly spaced, high-volume spray guns spaced evenly to distribute treated groundwater over a large area of ground surface. The treated groundwater would infiltrate the ground surface and recharge the surficial aquifer. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, would not be desirable to discharge treated groundwater into the surficial aquifer.

C2.6.3. Offsite

C2.6.3.1. NPDES-permitted outfall

Under this process option, the Mound Plant NPDES permit would be modified to include the discharge of treated groundwater from remediation activities at Operable Unit 1.

C2.6.3.2. Offsite Facility

Under this process option, contaminated groundwater would be containerized and transported to an approved offsite facility for disposal. Some pretreatment may first be required.

C2.7. DISPOSAL OF TREATMENT RESIDUALS FROM PRETREATMENT PROCESSES

C2.7.1. Onsite

If the treatment residuals from pretreatment process options exhibit hazardous waste characteristics, then an onsite disposal facility would be regulated by such regulations as RCRA. The quantity of residuals is estimated to be relatively small.

C2.7.2. Offsite

Disposal of the residuals associated with pretreatment process options could be accomplished at an approved, offsite facility.

APPENDIX D

CAPITAL AND FIRST-YEAR O&M COST ESTIMATES

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CORA Groundwater Monitoring Cost Module (503) D-1
Capital Cost Estimate: Fencing D-2
Capital Cost Estimate: Lining Ditches With Concrete D-3
CORA Soil Cap Cost Module (101) D-4
Capital Cost Estimate: Slurry Columns D-5
CORA Groundwater Extraction Cost Module (206) D-6
Capital Cost Estimate: UV/Oxidation D-7
Capital Cost Estimate: Permeable Treatment Wall D-8
CORA Discharge to Surface Water Cost Module (406) D-9

***** VERSION 3.0 DRAFT *****

DATE: 03/15/94
TIME: 21:24:26

CORA GROUNDWATER MONITORING COST MODULE (503)

SITE NAME: OU1 WITH 9 ALTS
OPERABLE UNIT: OU1 AREA B ESTIMATED START: MID FY 1994
SCENARIO: MODULES COMMON TO ALL SCENARIOS
RUN BY: PHONE NUMBER:

INPUTS

Parameter	Value
Number of wells to install	6
Average well depth (ft)	40
Protection during setup of drill rig & installation of above-grade piping	D
Protection during drilling	D
Average temp (degrees F)	75
Confidence level	H
Number of wells to monitor	15
Monitoring frequency	4
Monitoring requirements:	
24 Plasma Metals	Y
Pest/PCB	Y
GC-BN	N
GC-Acid	N
HSLORG	N
VOA GC/MS	Y
Acid GC/MS	N
B/N GC/MS	N

RESULTS

Component	Total
CAPITAL COST	40,000
O & M COSTS	75,000

Capital Cost Estimate
(vendor supplied costs for similar project at site)
Fencing

Capital	$/LF	LF	Cost Estimate	Year Incurred
Direct and Indirect	$17.46	2,200	$38,412	0
No Annual O&M Cost				

LF - linear feet

Capital Cost Estimate
(unit costs supplied by cost data manual, Means 1990)
Lining Ditches With Concrete

Capital	$/SF	SF	Cost Estimate	Year Incurred
Direct and Indirect	$3.64	17,850	$64,974	
Contingency (20% of TCC)			$16,244	
Total Capital Cost			$81,218	0
Annual O&M cost			$937	

SF - square feet

***** VERSION 3.0 DRAFT *****

DATE: 03/11/94
TIME: 13:49:27

CORA SOIL CAP COST MODULE (101)

SITE NAME: OU1 WITH 9 ALTS
OPERABLE UNIT: OU1 AREA B ESTIMATED START: MID FY 1994
SCENARIO: COLLECT/DISPOSAL/CAP
RUN BY: PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Area of site (acres)	1.00	CAPITAL COST	170,000
Soil type	Topsoil	O & M COSTS	16,000
Leveling layer (ft)	0.5		
Protective layer (ft)	1.5		
Topsoil layer (ft)	0.5		
Protection level	D		
Average temp (degrees F)	75		
Confidence level	H		

*** Costs for areas larger than 50 acres do not take into account potential variations for material availability.

Costs for this module are sensitive to the material costs for the soil barrier and top soil. Material costs used to develop the algorithm are $21.50/cy for the soil barrier (clay) and $14.00/cy for top soil. Should local costs vary, the estimate should be adjusted to reflect the local economy.

Capital Cost Estimate
(vendor supplied unit costs)
Slurry Columns

Capital	$/VSF	VSF	Cost Estimate	Year Incurred
Direct and Indirect	$7.50	37,600	$282,000	0
Mob/Demob			$180,000	0
Total			$462,000	
No Annual O&M Cost				

VSF - vertical square feet

***** VERSION 3.0 DRAFT *****

DATE: 03/09/94
TIME: 14:39:59

CORA GROUNDWATER EXTRACTION COST MODULE (206)

SITE NAME: OU1 WITH 9 ALTS
OPERABLE UNIT: OU1 AREA B ESTIMATED START: MID FY 1994
SCENARIO: COLLECT/TREAT/DISP/CAP
RUN BY: PHONE NUMBER:

INPUTS

Parameter	Value
Number of wells known?	Y
Number of wells	2
Pumping rate per well (GPM)	10.0
Well diameter (inches)	8
Will wells be gravel packed?	Y
Average well depth (ft)	40
Transfer piping length (ft)	1200
Pumping water level/well (ft)	30
Average temp (degrees F)	75
Confidence level	L
Protection above grade	D
Protection during drilling	D

RESULTS

Component	Total
CAPITAL COST	43,000
O & M COSTS	13,000
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
WELL CUTTINGS (CY) (SWELL FACTOR=1.25)	3

Capital Cost Estimate
(vendor supplied unit costs)
UV/Oxidation

Capital	Equipment		Cost Estimate	Year Incurred
Direct and Indirect	$245,000	LS	$245,000	0
Treatability			$3,500	0
Total			$248,500	
Annual O&M Cost	$0.84/ 1000 Gal	21,024 1000 Gal/yr	$17,660.16	

LS - lump sum
Gal - gallon
yr - year

Capital Cost Estimate
(vendor supplied unit costs)
Permeable Treatment Wall

Capital	$/VSF	VSF	Cost Estimate	Year Incurred
Direct and Indirect	$7.50	35,250	$264,375	0
Reactive Wall Instl			$630,400	0
Mob/Demob			$180,000	0
Bench Scale			$30,000	0
Total			$1,104,775	
No Annual O&M Cost				

VSF - vertical square feet

***** VERSION 3.0 DRAFT *****

DATE: 03/09/94
TIME: 14:41:21

CORA DISCHARGE TO SURFACE WATER COST MODULE (406)

SITE NAME: OU1 WITH 9 ALTS
OPERABLE UNIT: OU1 AREA B ESTIMATED START: MID FY 1994
SCENARIO: COLLECT/TREAT/DISP/CAP
RUN BY: PHONE NUMBER:

INPUTS

Parameter	Value
Transmission main	Press.
Flow (GPM)	20
Length of line (ft)	1200
Depth of line (ft)	5
Average temp (degrees F)	75
Confidence level	L
Protection level	D

RESULTS

Component	Total
CAPITAL COSTS	
BASE CAPITAL COST	140,000
NPDES PERMIT	50,000
TOTAL CAPITAL COST	190,000
O & M COSTS	750

APPENDIX E

RECOVERY WELL CAPTURE ZONE MODELING

E1. RECOVERY WELL CAPTURE ZONE MODELING

E2. TRAVEL TIME CALCULATION

E3. REFERENCES

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ACRONYMS

COC	contaminant of concern
EPA	U.S. Environmental Protection Agency
GPTRAC	General Particle Tracking
PCE	tetrachloroethene
RIR	remedial investigation report
VOC	volatile organic compound

UNITS OF MEASURE

ft	feet
ft^2/day	square feet per day
gpm	gallons per minute

E1. RECOVERY WELL CAPTURE ZONE MODELING

E1.1. OBJECTIVES

An analytical groundwater flow model (EPA 1993) is used to predict optimum locations and pumping rates of groundwater recovery wells so that capture zones are formed that intercept the contaminated groundwater in Area B and prevent it from moving offsite (as in Alternatives 3, 4, and 5). A groundwater flow model is also used to predict optimum locations and pumping rates of groundwater recovery wells within Area B and outside Area B if Area B were bordered by a subsurface barrier on the south and west sides (as in Alternatives 6 and 7).

E1.2. METHOD

The General Particle Tracking (GPTRAC) computational module of the U.S. Environmental Protection Agency (EPA) Well Head Protection Area Delineation Code (EPA 1993) is used for capture zone prediction. This semi-analytical model delineates time-related capture zones for pumping wells. Based on the results of the aquifer tests reported in the remedial investigation report (RIR) (DOE 1994a), the aquifer is assumed to be homogenous; and groundwater flow is assumed to be steady, uniform, and horizontal. The aquifer in Area B was assumed to be unconfined.

The model area is 300 feet (ft) by 500 ft and extends from 100 ft south of Area B to 100 ft north of the southern edge of the overflow pond (Figure E.1). A linear and fully penetrating barrier boundary coinciding with the approximate boundary of the Buried Valley aquifer was assumed for the eastern edge of the model area. The western boundary coincides approximately with the road paralleling the western property line of the Mound Plant. At the western boundary, the aquifer is approximately 16 ft thick. Toward the east, the aquifer decreases in thickness to zero as the glacial outwash deposits thin against the bedrock valley wall.

Because of the wedge-like shape of the aquifer under Area B and because the model requires a homogeneous saturated thickness, the actual capture zones would extend further toward the east than are shown on the output figures; therefore, the capture zone model would produce conservative results. Conservative zone model output, which is based on conservative input parameters (such as the homogeneous saturated thickness) is effective in evaluation of the feasibility of groundwater extraction as a remediation option and for cost estimation of this option. If an option is selected that involves groundwater extraction or permeable treatment walls, three-dimensional, distributed parameter, groundwater flow modeling should be performed to facilitate remediation design.

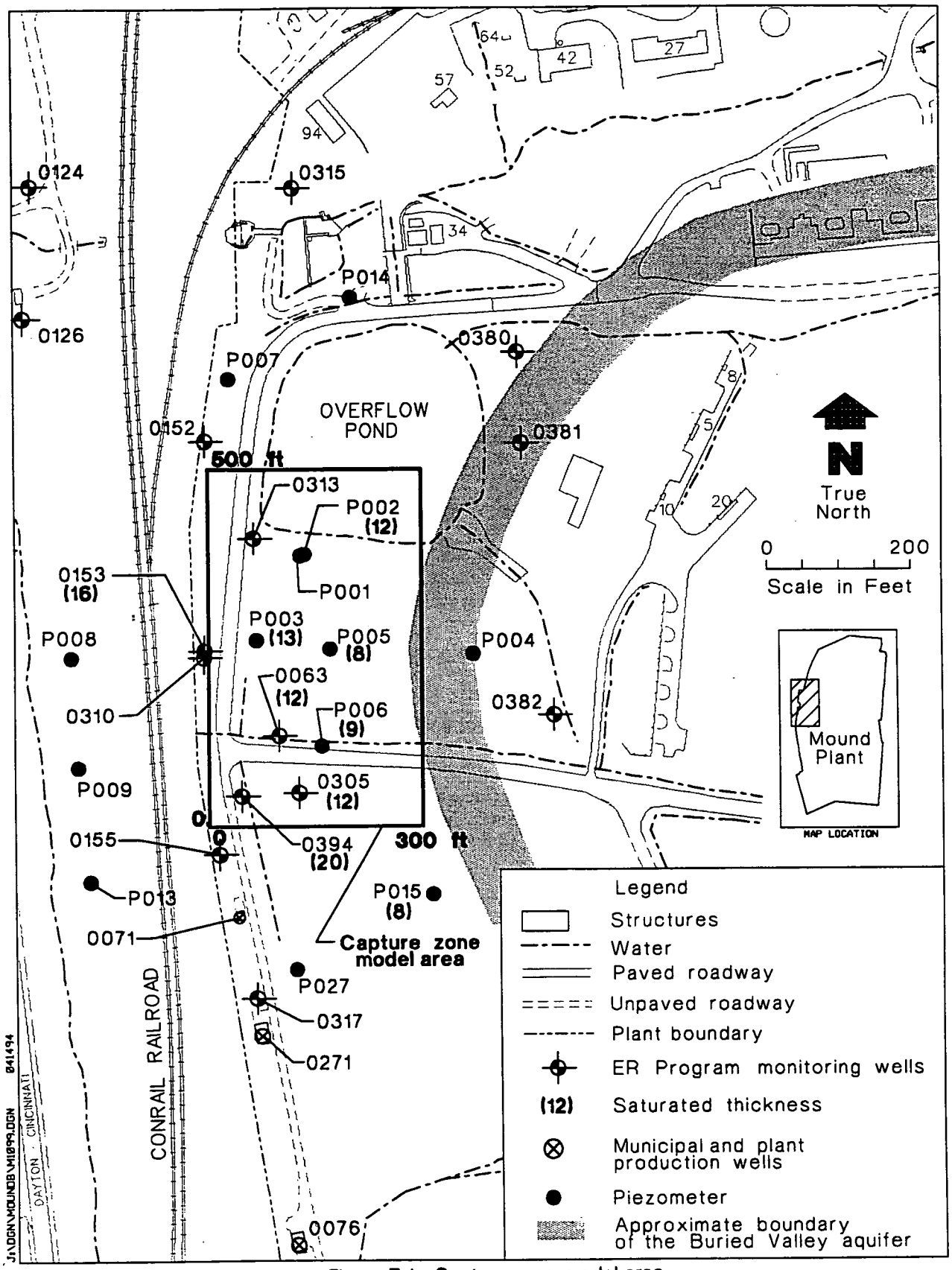


Figure E.1. Capture zone model area.

E1.3. INPUT PARAMETERS

Aquifer properties required by the GPTRAC model and their range of variation used in sensitivity analyses are shown in Table E.1. These aquifer properties and the data used to estimate them were obtained from the Operable Unit 1 RIR (DOE 1994a).

Table E.1. Model Inputs for GPTRAC

Aquifer Property	Transmissivity (ft^2/day)	Saturated Thickness (ft)	Ambient Flow Direction	Hydraulic Gradient
Range	33,000 - 40,000	8 - 16	North 15° West to North 15° East	0.0006 - 0.003

Other properties required by the model include spacial step length, areal recharge rate, well radius, and radius of influence. The spacial step length was set at 20 feet. An areal recharge rate of 0.0001 ft per day was used in all capture zone scenarios; however, it was also increased up to 0.005 ft per day in the sensitivity analyses. A 0.5 ft well radius was used for all extraction wells and a radius of influence of 100 ft with containment and a radius of influence of 70 ft without containment were used for starting the model iterations.

E1.3.1. Transmissivity

Transmissivity values for Operable Unit 1 were determined from an aquifer test conducted in 1993 (DOE 1994a). Glacial outwash transmissivity estimates were reported for two piezometers (P005 and P006) in Area B. A transmissivity estimate was also reported for one piezometer south of Area B (P027) and two piezometers southwest of Area B (P009 and P013). The average of the two transmissivities estimated for P005 and P006 were used in the model (36,500 ft^2/day). For sensitivity analyses, a range of transmissivity values from P005, P006, and P027 were used to observe the effects of transmissivity variation on the capture zone results. The values of P009 and P013 were not used because these wells are in an area of the Buried Valley aquifer of much greater saturated thickness.

Transmissivities for Area B can also be determined by using the average hydraulic conductivity from the aquifer test (680 ft^2/day) (DOE, 1994) and the average saturated thickness for Area B (12 ft). This average would give an approximate transmissivity of 8000 ft^2/day, which is over four times less than that presented above. If this transmissivity were used in the model, the capture zones would expand

in size. However, because the purpose of the model is to judge the feasibility of groundwater extraction and not remediation design, the more conservative (higher) transmissivity was used. If an option is selected that involves groundwater extraction, the full range of transmissivities would be considered in remedial design.

E1.3.2. Saturated Thickness

The saturated thickness of the glacial outwash within Area B and surrounding areas was estimated from well boring logs (DOE 1994b and DOE 1992). The saturated thickness ranges from zero at the boundary of the Buried Valley aquifer to approximately 16 ft at monitor well 0153 on the western edge of Area B. Just south of Area B at monitor well 0394, the saturated thickness is approximately 20 ft (Figure E.2). To produce conservative estimates, a saturated thickness of 12 ft was used for most capture zone determinations instead of 8 ft. For sensitivity analyses, a range of saturated thicknesses was used to observe the effects of saturated thickness variation on capture zone results.

E1.3.3. Ambient Groundwater Flow Direction

The ambient groundwater flow direction was determined from the quarterly groundwater elevation data and maps presented in the RIR and Appendices (DOE 1994a). These maps show a steep hydraulic gradient to the west within the bedrock east of Area B and a more gradual gradient from north to south or northeast to southwest in the Buried Valley aquifer across Area B (Figure E.3). Another figure in the RIR of Area B only shows groundwater elevation contours at an interval of tenths of feet and a flow direction from northwest to southeast across Area B (Figure E.4). Therefore, the flow directions most likely range from south 15° west to 15° east toward the Mound Plant production wells. Once more, water levels were collected from piezometers and monitor wells within Area B, and the range of possible flow directions may expand. Capture zones and optimum pumping rates were determined for the range of flow directions stated above.

E1.3.4. Hydraulic Gradient

The hydraulic gradients used as model input were determined from water level data collected from monitor wells in Area B. The hydraulic gradients, therefore, reflect the effects of overflow pond leakage and production well withdrawals on the groundwater system of Area B. Multiple sets of water level data were available for outwash monitor wells on the western side of Area B (0313, 0153, and 0305) only. Water level data from the piezometers and wells numbered greater than 0370 were available for one sampling event only (March 1993). This data is presented in Figure E.4. Monitor well 0155 water level elevations were not used for this map because it was surveyed with inaccurate

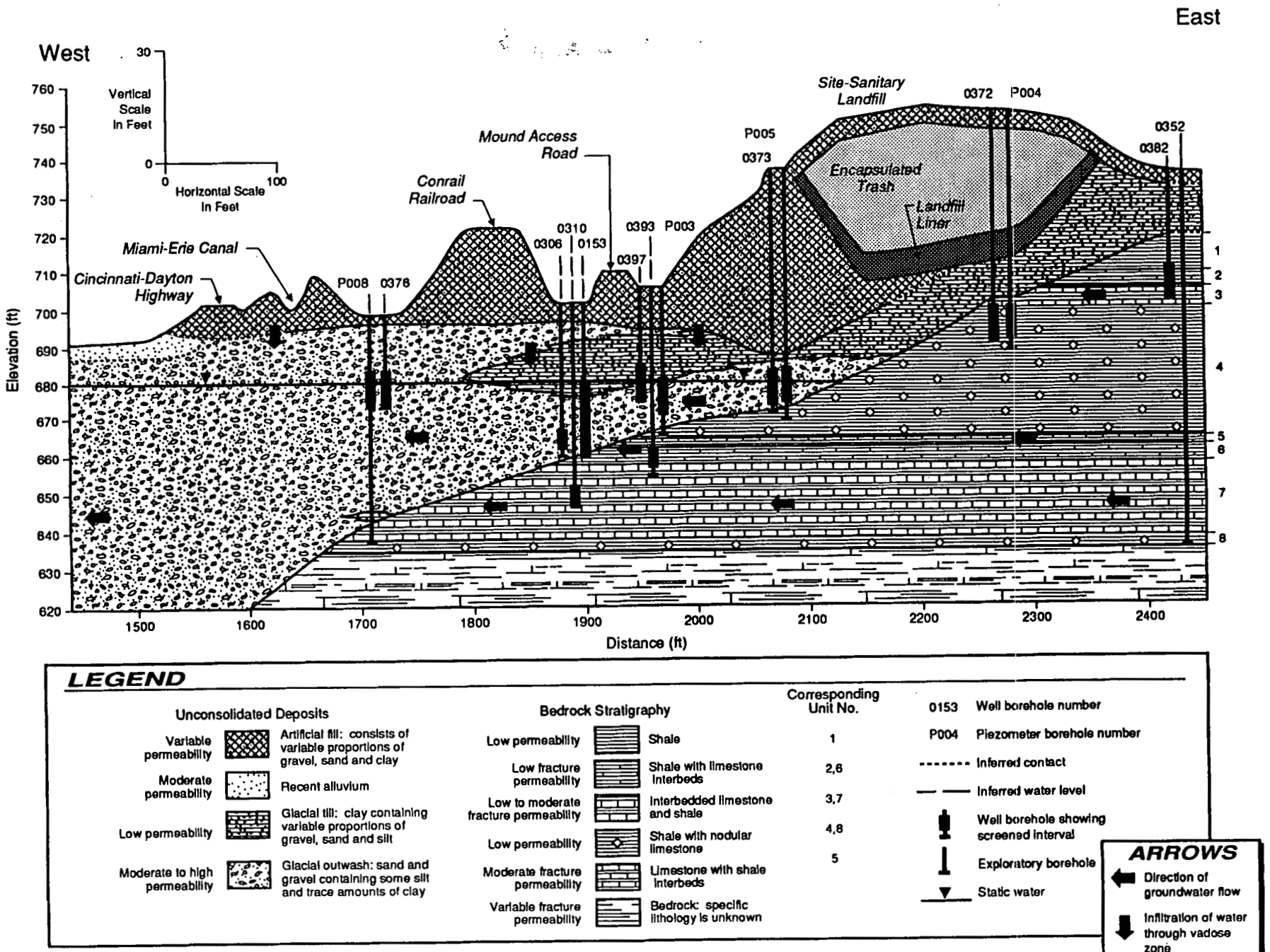


Figure E.2. Area B east-west cross section.

MND/OU1/FS/B2-B6 5-24-94

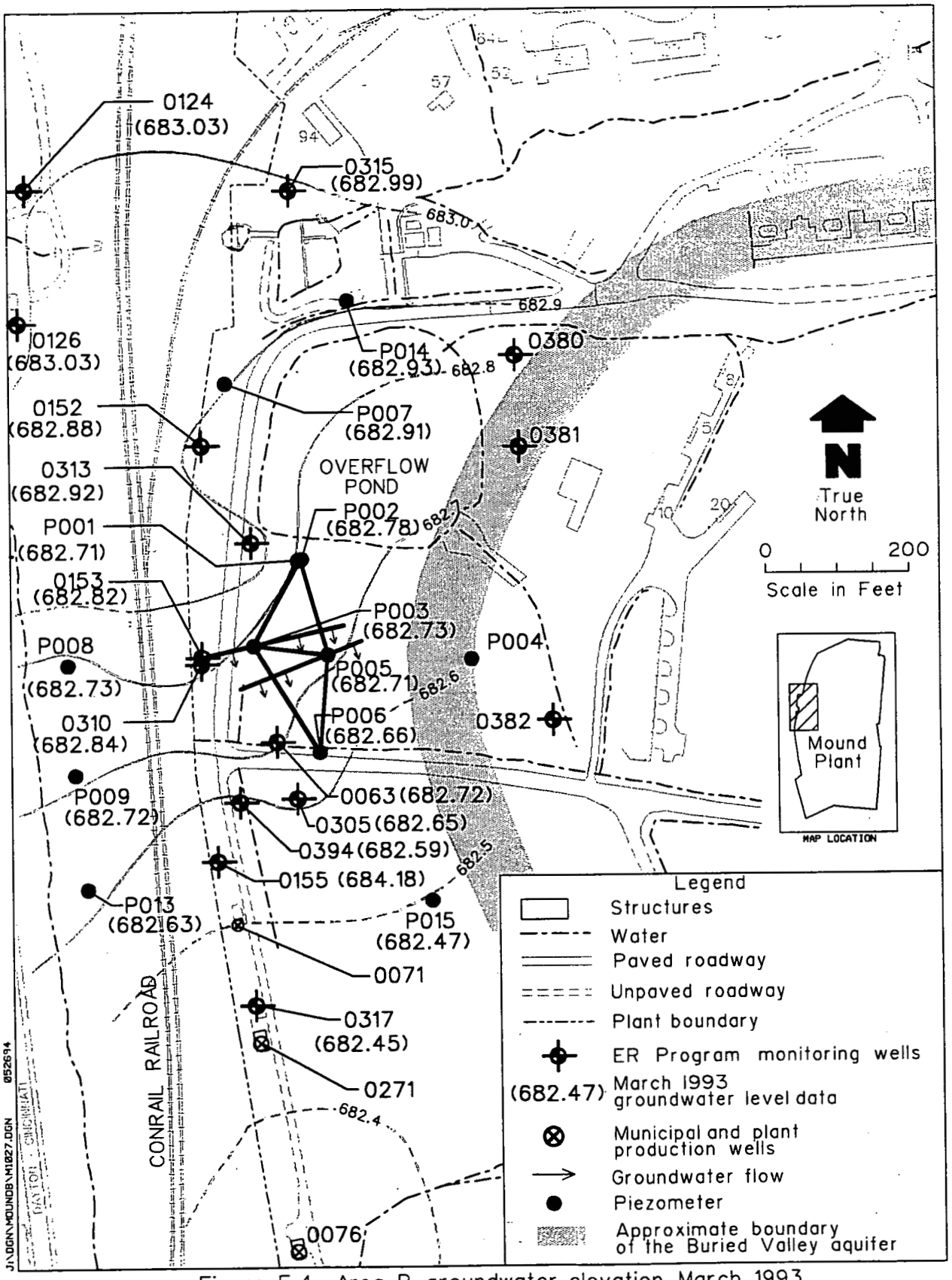


Figure E.4. Area B groundwater elevation, March 1993.

benchmark datum (DOE, 1994a). Three sets of water level elevation data and three-point gradient calculations for monitor wells 0313, 0153, and 0305 are presented in Figures E.4 through E.6 and Table E.2. The hydraulic gradients were calculated using groups of three wells within Area B to solve three-point problems. In Figures E.3, E.5, and E.6, the groups are delineated with triangles, and groundwater flow direction is indicated by arrows from the line perpendicular to groundwater flow. Gradients were determined using a well upgradient and a well downgradient from the line perpendicular to flow. Hydraulic gradients ranged from approximately 0.0009 in June 1992 to approximately 0.0005 in March 1993 with 0.0008 in September 1992 (Table E.2). A conservatively high gradient of 0.0008 was taken as the representative hydraulic gradient for Area B. A hydraulic gradient range of 0.0006 to 0.003 was used for the sensitivity analysis.

Table E.2. Hydraulic Gradient Calculations

Figure Number	Water level elevation	Horizontal Distance between elevations (ft.)	Hydraulic gradient
E.3	682.78 - 682.82	100	0.0005
E.3	682.71 - 682.66	120	0.0004
E.5	680.74 - 680.68	80	0.00075
E.5	680.68 - 680.49	240	0.00079
E.6	679.61 - 679.55	70	0.00086
E.6	680.68 - 679.41	240	0.0010

For the capture zone scenario in which Area B is bounded by a slurry wall on the south and west sides, the hydraulic gradient was assumed to be almost flat. This assumption was made because a partial barrier would prevent groundwater flow from the northwest into Area B, and barriers would prevent groundwater flow out from Area B from the north or northeast.

E1.4. RESULTS

E1.4.1. Optimum Recovery Well Configuration With No Area B Containment

This capture zone scenario applies to Alternatives 3, 4, and 5, which require groundwater collection but no containment. The optimum number, locations, and pumping rates for recovery wells were determined by using the GPTRAC capture zone model to estimate capture zones for the ranges of aquifer properties described above. Optimum capture zones that cover the greatest areal extent of Area B at the lowest pumping rates were determined.

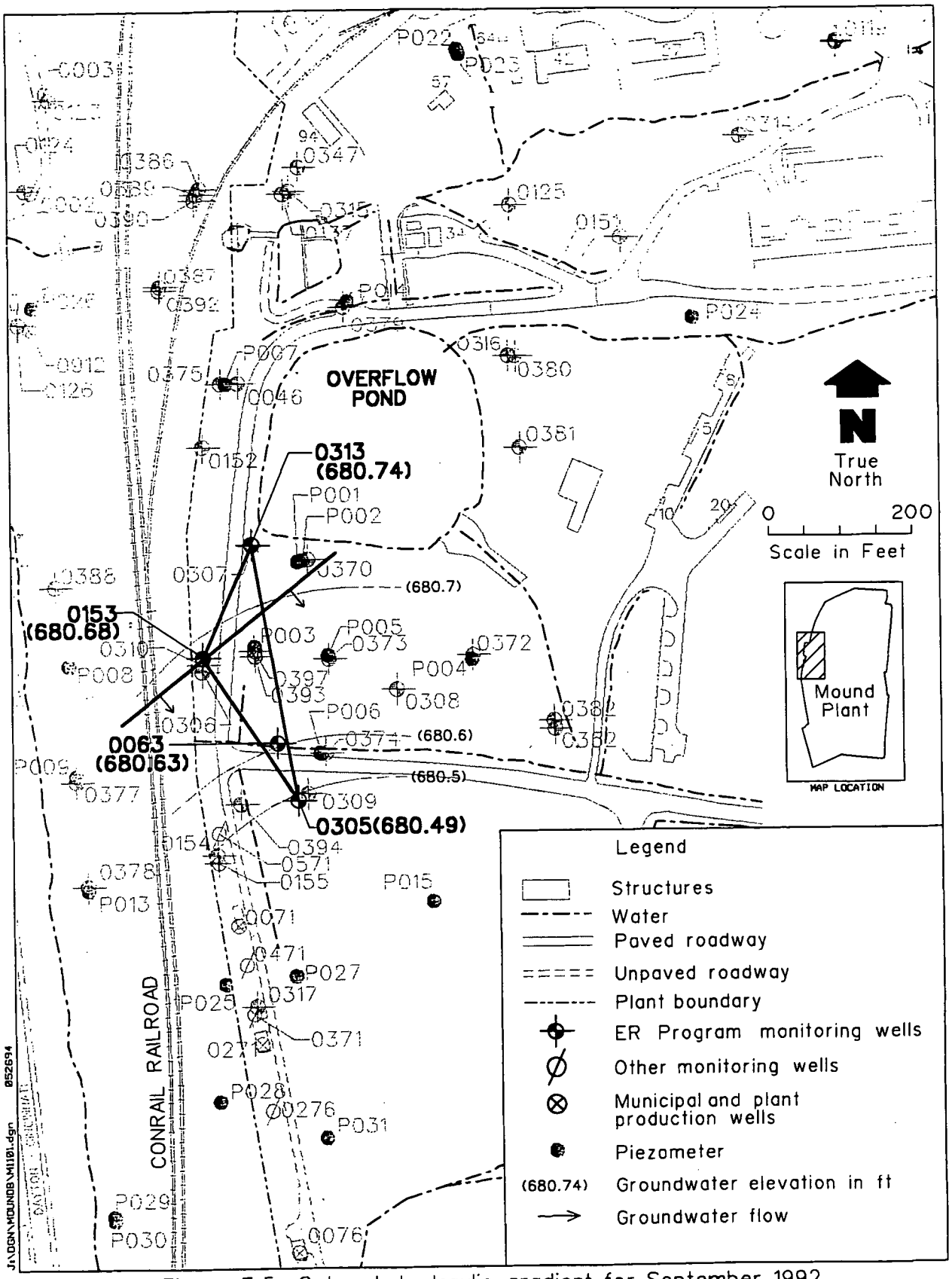


Figure E.5. Outwash hydraulic gradient for September 1992.

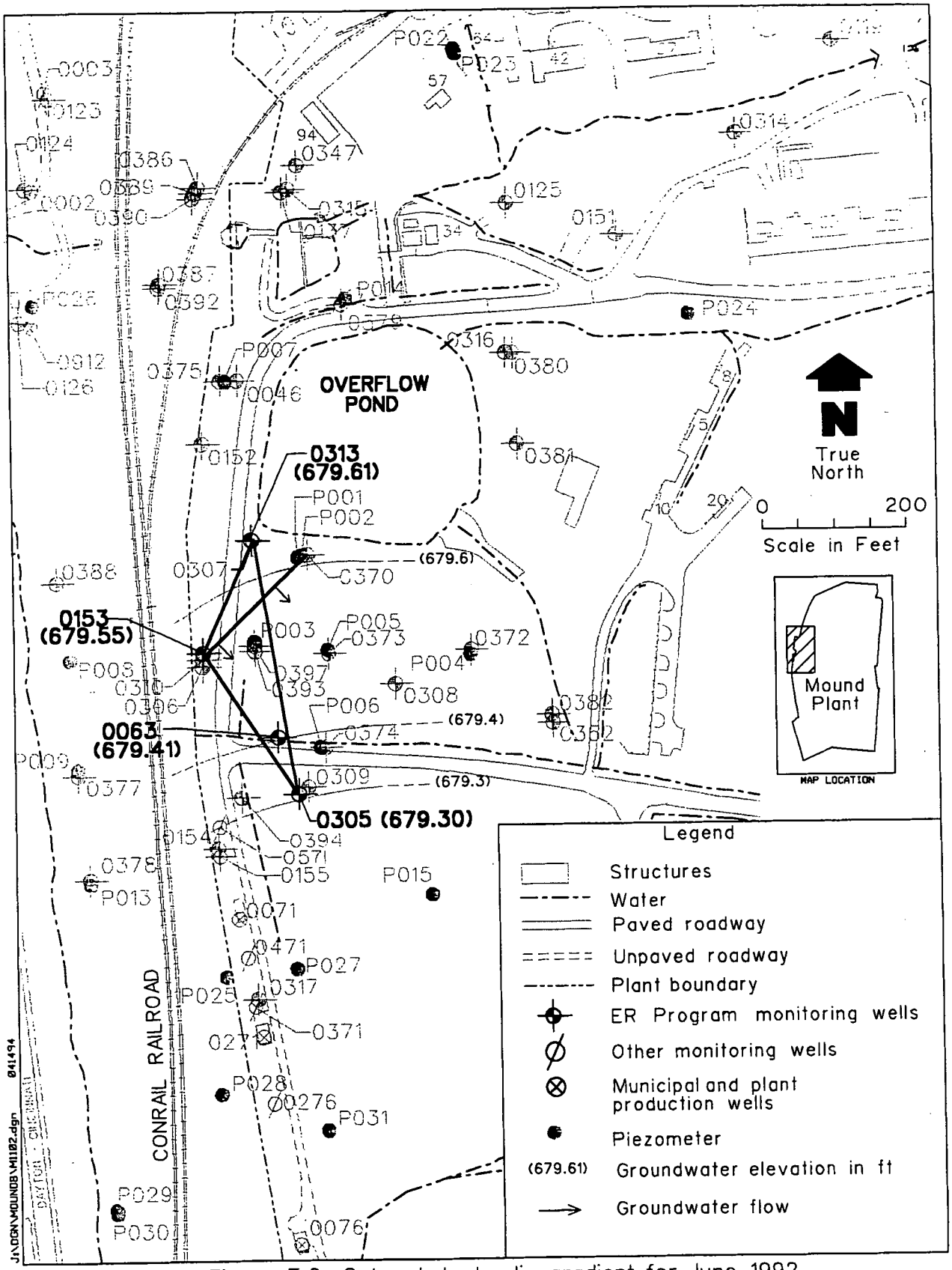


Figure E.6. Outwash hydraulic gradient for June 1992.

The most effective combination of locations and pumping rates requires two recovery wells pumping a total of 45 gallons per minute (gpm). One well (Well No. 1) would be located in the southwest corner of Area B (40 ft west of monitor well 0063) and the other (Well No. 2) would be located approximately 80 ft east of Well No.1 (Figures E.7 and E.8). With Well No. 1 pumping at 20 gpm and Well No. 2 pumping at 25 gpm, a capture zone that covers most of Area B would be formed. In reality, these capture zones would actually be larger for two reasons:

- Because the aquifer decreases in saturated thickness toward the east, the capture zone would expand to compensate for the decreasing saturated thickness.
- The model artificially constrains the flow paths to the grid size increments.

E1.4.2. Optimum Recovery Well Configuration With Area B Containment

This capture zone scenario applies to Alternatives 6 and 7, which require groundwater collection with Area B containment. To simulate these capture zones the southern model boundary was moved 100 ft to the north to coincide with the proposed location of the subsurface barrier, and the western boundary was changed to a no-flow boundary to simulate the subsurface barrier.

The most effective combination of locations and pumping rates, when Area B is bounded on the south and west by a subsurface barrier, requires three recovery wells pumping a total of 12 gpm. One well (Well No. 1) would be located between the landfill and the west road (near piezometer P003). Another well (Well No. 2) would be located between the landfill and the south road (near monitor well 0063). The third well would also be located between the landfill and the south road approximately 20 ft east of piezometer P006 (Figures E.9 and E.10). With Well No. 1 pumping at 5 gpm, Well No. 2 pumping at 2 gpm, and Well No. 3 pumping at 5 gpm, a capture zone would be formed that covers most of Area B. In reality, these capture zones would actually be larger for two reasons:

- Because the aquifer decreases in saturated thickness toward the east, the capture zone would expand to compensate for the decreasing saturated thickness.
- The model artificially constrains the flow paths to the grid size increments.

If groundwater contamination is found south of the Area B containment barrier, it could be extracted with a recovery well located near monitor well 305 (Figure E.1). Because this area is downgradient of a subsurface barrier to groundwater flow, a very low hydraulic gradient would be expected. An

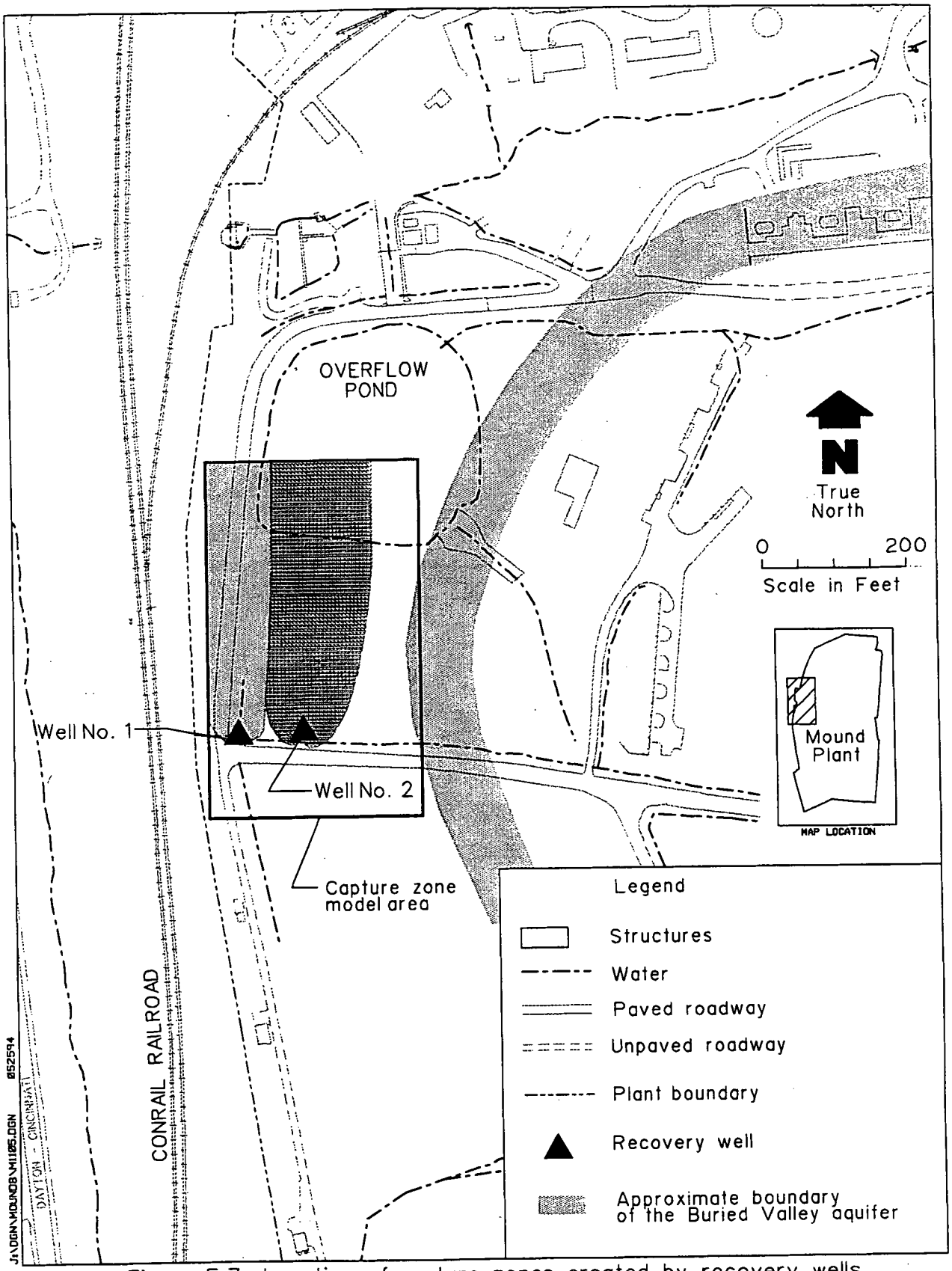
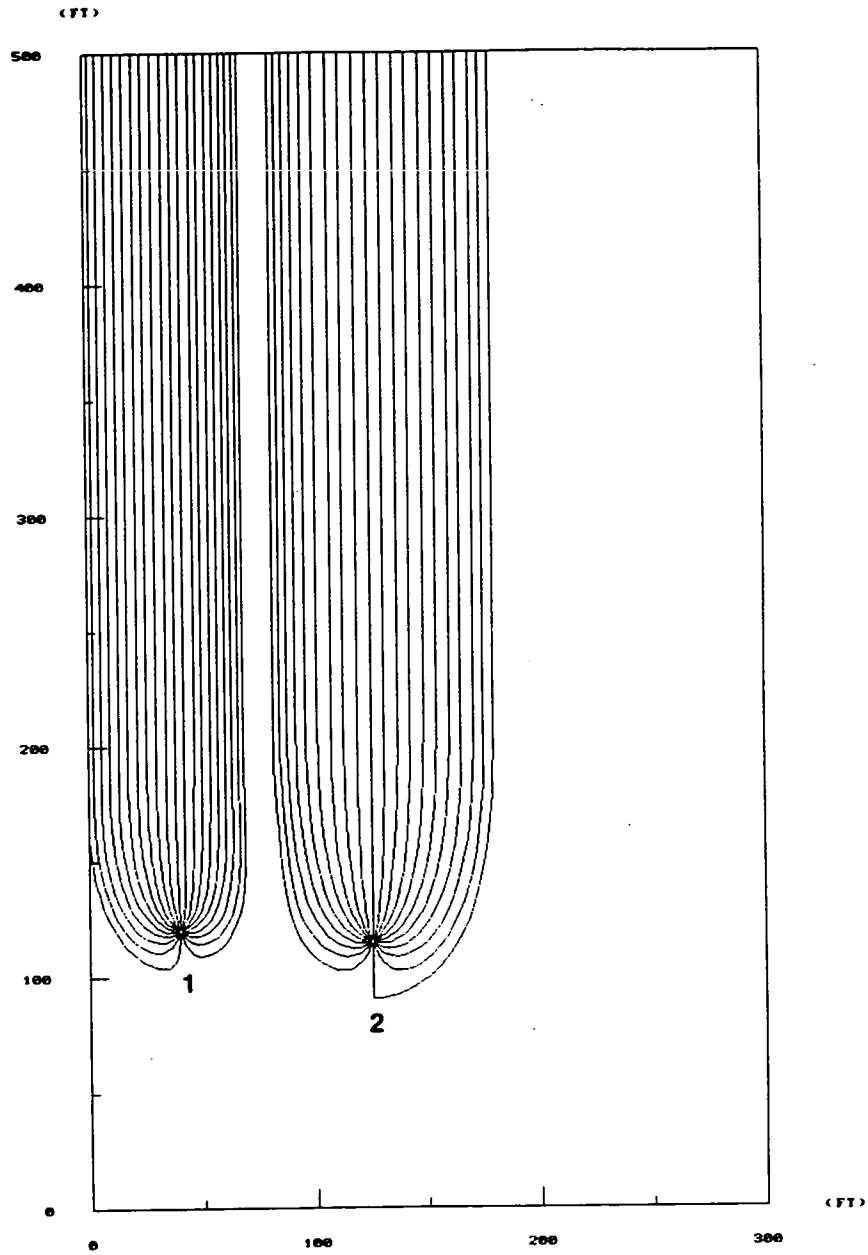


Figure E.7. Location of capture zones created by recovery wells.



Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0008
saturated thickness = 12 ft
flow direction = N-S

Figure E.8. Capture zones with no containment.

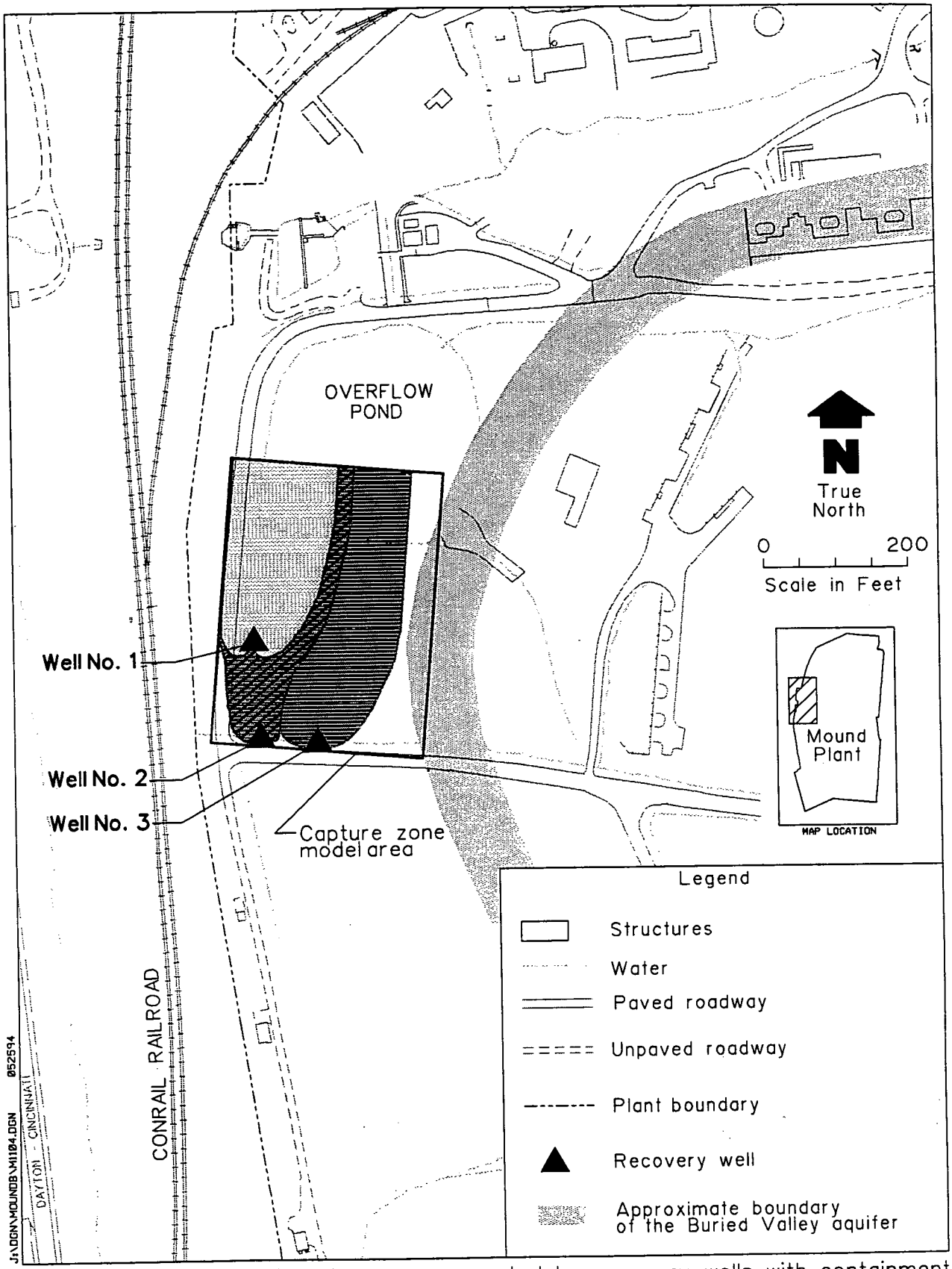
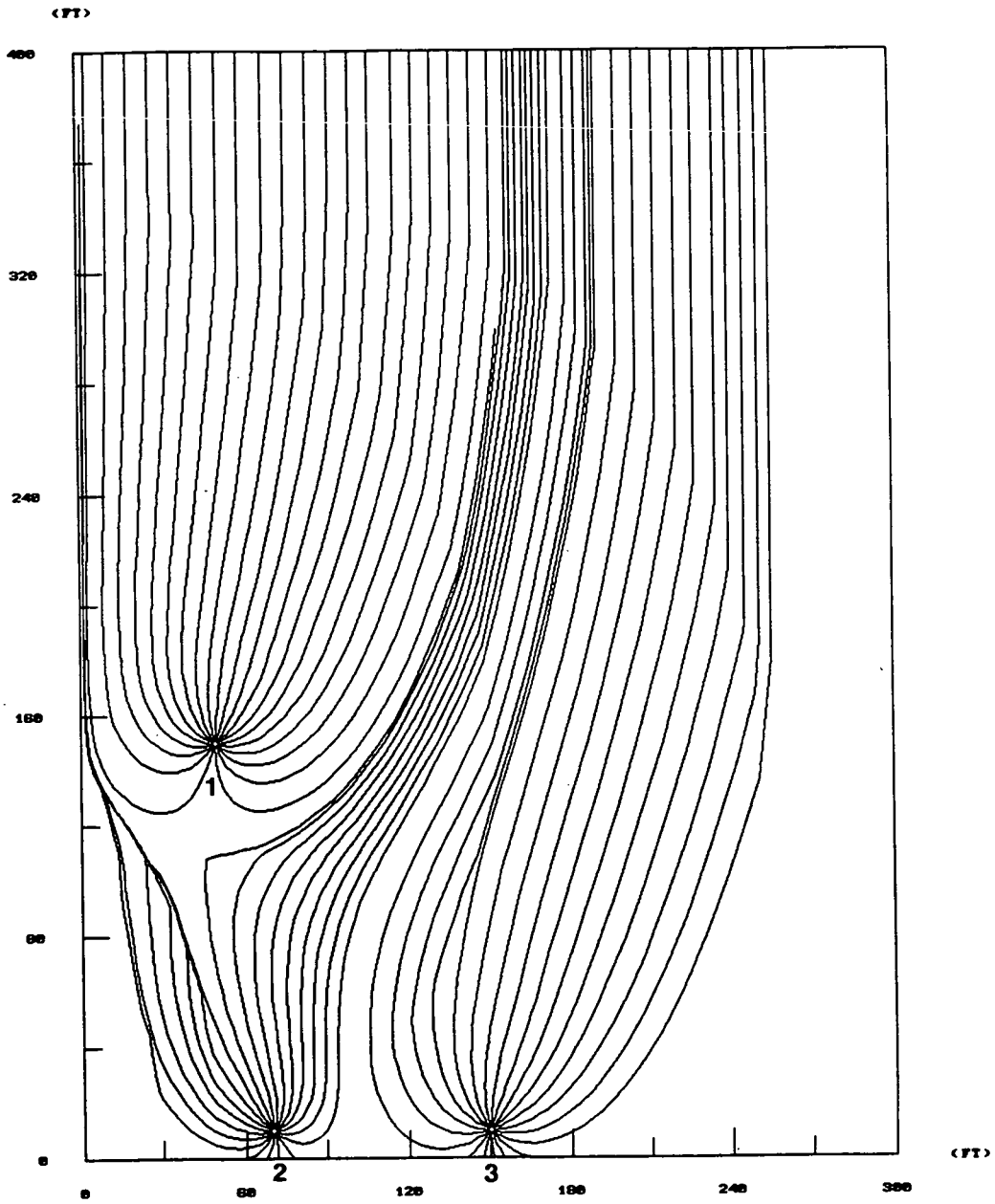


Figure E.9. Location of capture zones created by recovery wells with containment.



Well No. 1 @ 5 gpm
Well No. 2 @ 5 gpm
Well No. 3 @ 2 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0001
saturated thickness = 12 ft
flow direction = N-S

Figure E.10. Capture zones with containment.

extraction well pumping at a rate as low as 5 gpm would form a capture zone approximately 175 ft wide (Figure E.11).

E1.4.3. Effects of Aquifer Property Variations

Aquifer properties were varied within the ranges described above to determine their effects on the capture zone configurations. Table E.3 shows the input parameters for each capture zone model run, and Figures E.12 through E.14 show the effects of hydraulic gradient variation. When the hydraulic gradient is 0.003, very little of the groundwater flow out of Area B is captured. However, when the gradient is from 0.0006 to 0.0008, almost all of the groundwater flow out of Area B is captured. Therefore, the capture zone is highly dependent on the hydraulic gradient.

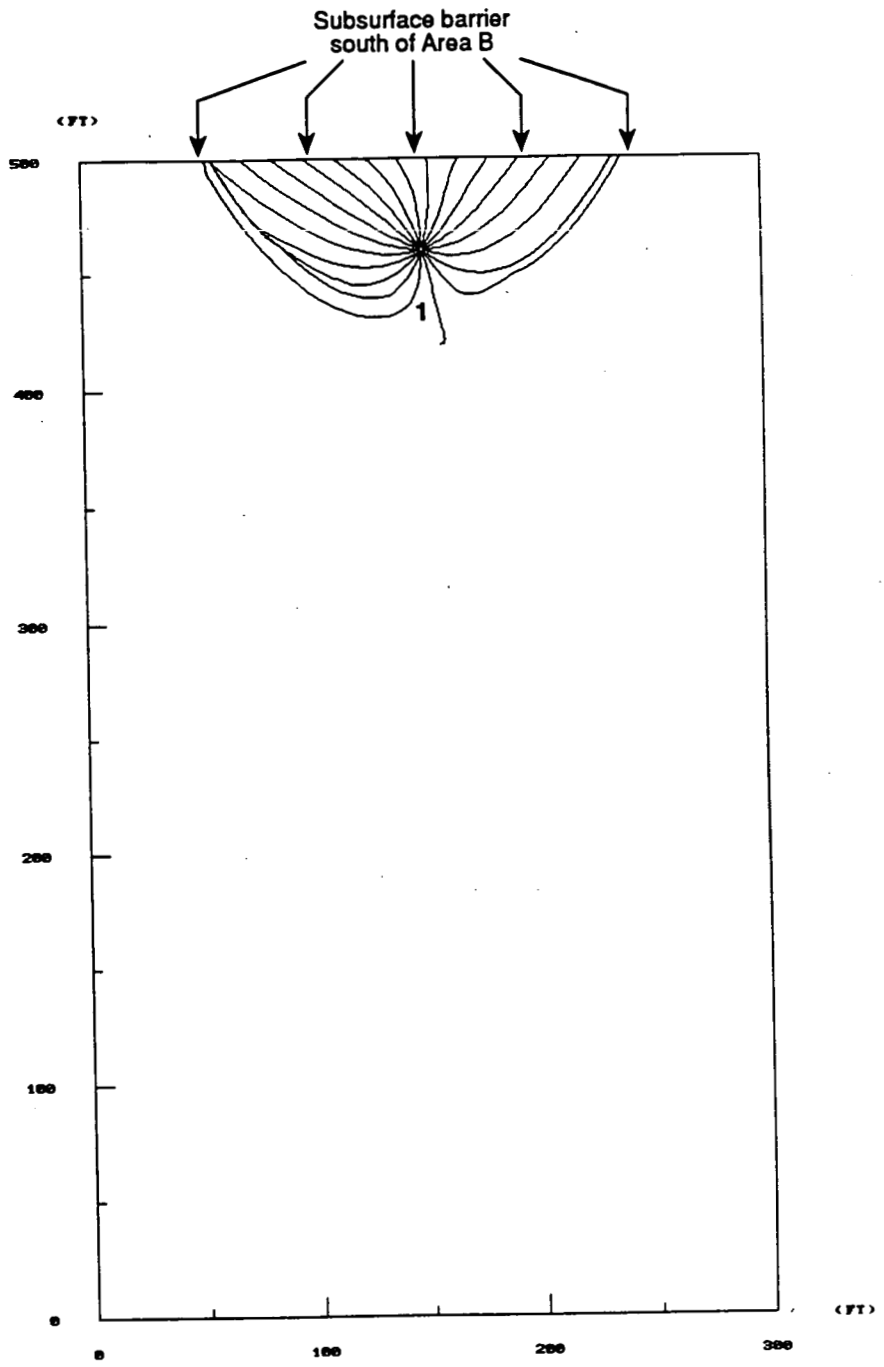
Figures E.15 and E.16 show the effects of groundwater-flow direction variation. When groundwater flows south 15° west, the two recovery wells still recover most groundwater flow out of Area B. However, when the groundwater flows south 15° east toward the southeast, another well would have to be added to capture most of the groundwater. Therefore, the effective capture zones are also highly influenced by variations in groundwater flow direction.

Figures E.17 and E.18 show that when the saturated thickness ranges from 8 to 16 ft there is very little effect on capture zone size. This lack of effect is because the simulated steady-state capture zone size is not dependent on aquifer thickness because the aquifer thickness only effects the velocity of groundwater flow. Time-related capture zone size would be dependent on groundwater velocity (EPA 1993).

Infiltration was also varied from 2 to 20 inches per year (average precipitation is 40 inches per year). The simulated capture zone size was not affected by this variation.

Figures E.19 and E.20 show the effect of increasing transmissivity from 33,000 ft^2/day to 40,000 ft^2/day. At the higher transmissivity, there is a slight decrease in capture zone size because the higher transmissivity increases the ambient groundwater flow.

In summary, the capture zone configurations are most sensitive to variations in hydraulic gradient and groundwater flow direction. These two aquifer properties vary seasonally and would have to be taken into account by frequent monitoring of the groundwater flow system and adjusting of the number of wells pumping and their pumping rates when necessary.

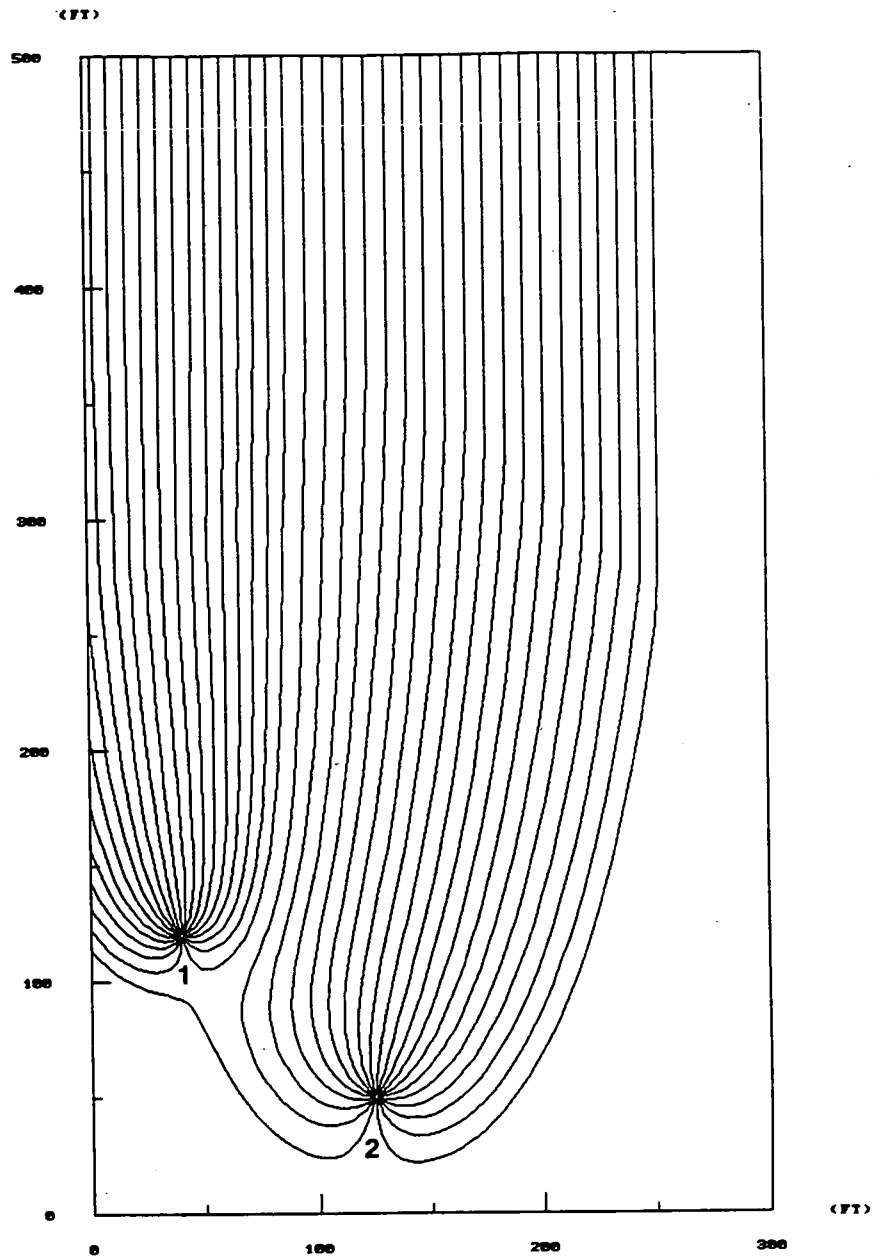


Well No. 1 @ 5 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0001
saturated thickness = 12 ft
flow direction = N-S

Figure E.11. Capture zone south of Area B containment.

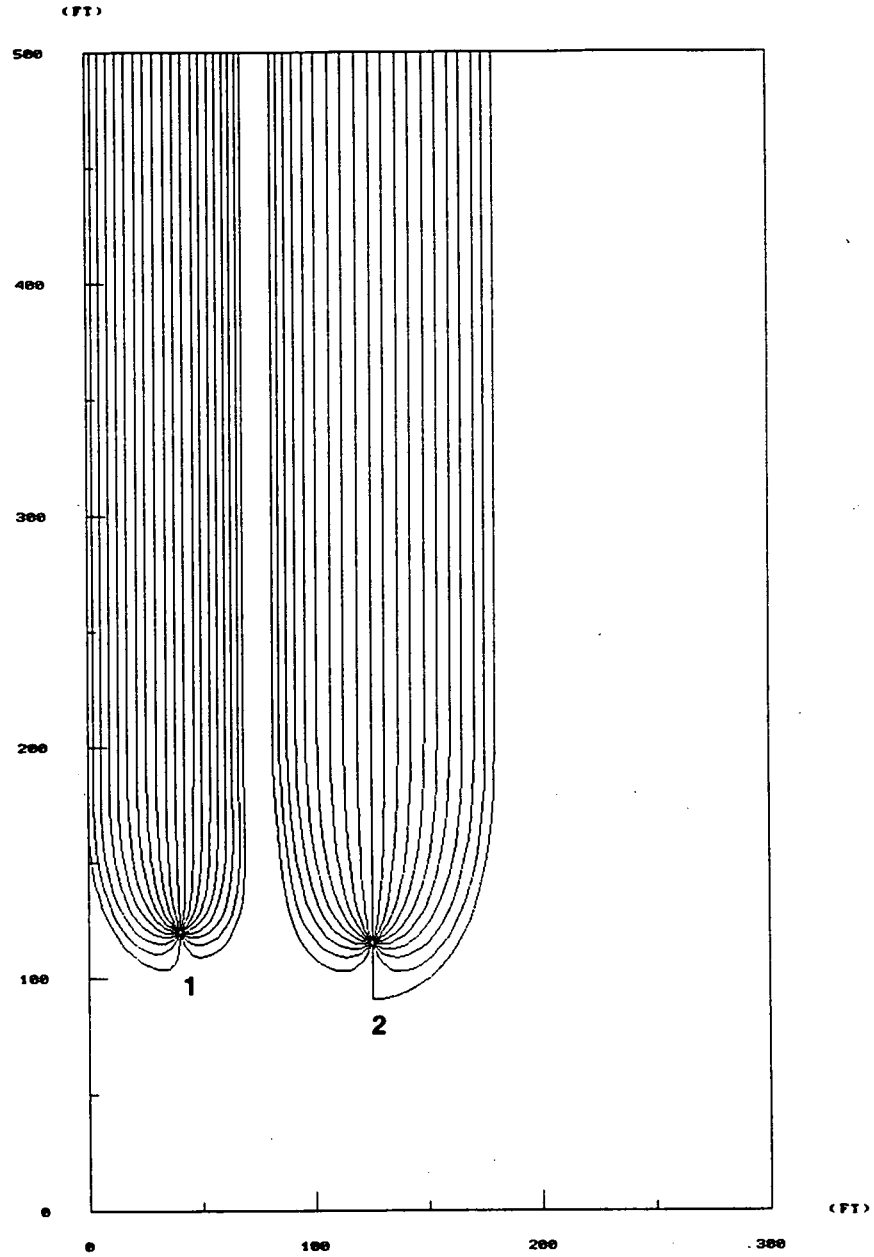
Table E.3. Variation of Input Parameters

Figure No. - file name	Well 1 Rate (gpm)	Well 2 Rate (gpm)	Well 3 Rate (gpm)	T (ft^2/ day)	Gradient	Direction of flow
E-10 - ou1run18	5	5	2	36500	0.0001	N-S
E-11 - ou1run18	5	-	-	36500	0.0001	N-S
E-8, E-13 - ou1run20	20	25	-	36500	0.0008	N-S
E-12 - ou1run24	20	25	-	36500	0.0006	N-S
E-14 - ou1run21	25	25	-	36500	0.003	N-S
E-15 - ou1run23	20	25	-	36500	0.0008	S 15° W
E-16 - ou1run22	20	25	10	36500	0.0008	S 15° E
E-17 - ou1run25	20	25	-	36500	0.0008	N-S
E-18 - ou1run26	20	25	-	36500	0.0008	N-S
E-19 - ou1run27	20	25	-	33000	0.0008	N-S
E-20 - ou1run28	20	25	-	40000	0.0008	N-S



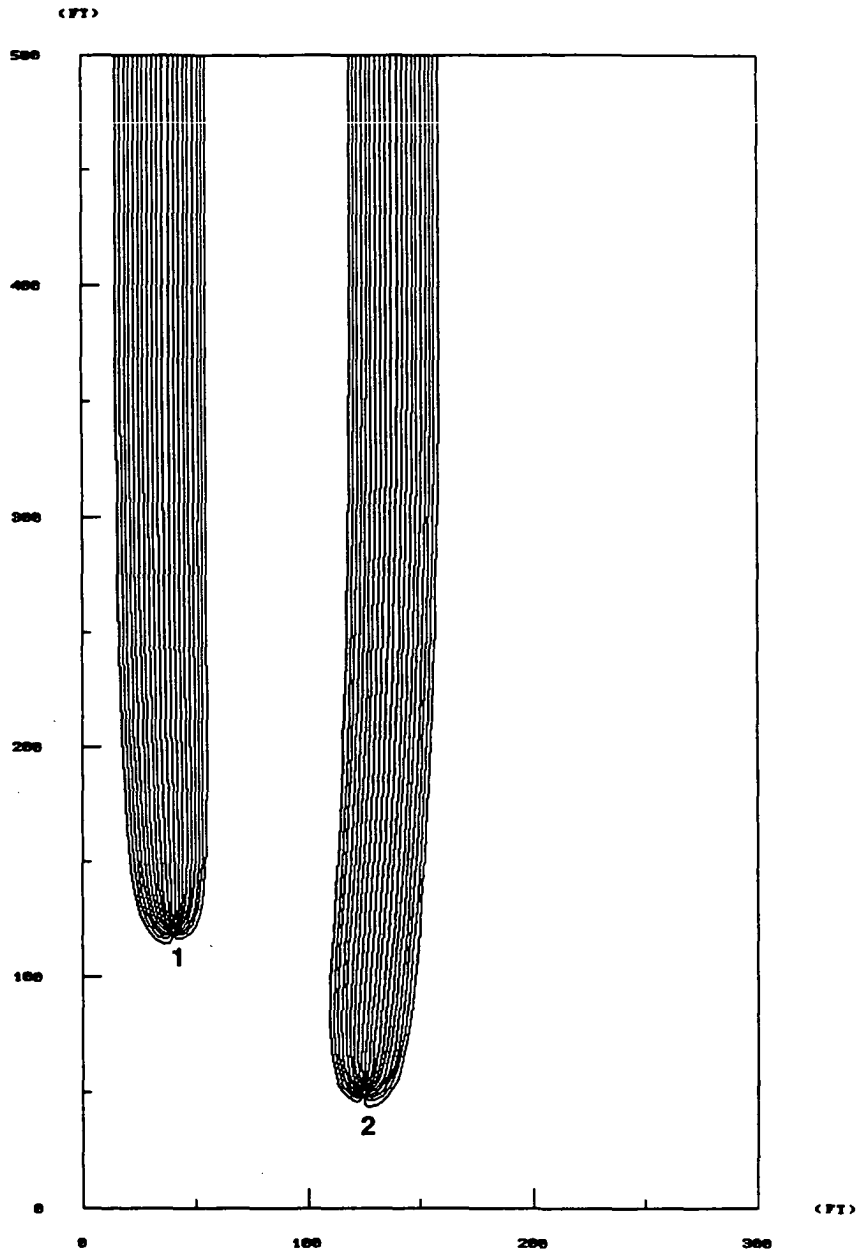
Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0006
saturated thickness = 12 ft
flow direction = N-S

Figure E.12. Capture zones with hydraulic gradient of 0.0006.



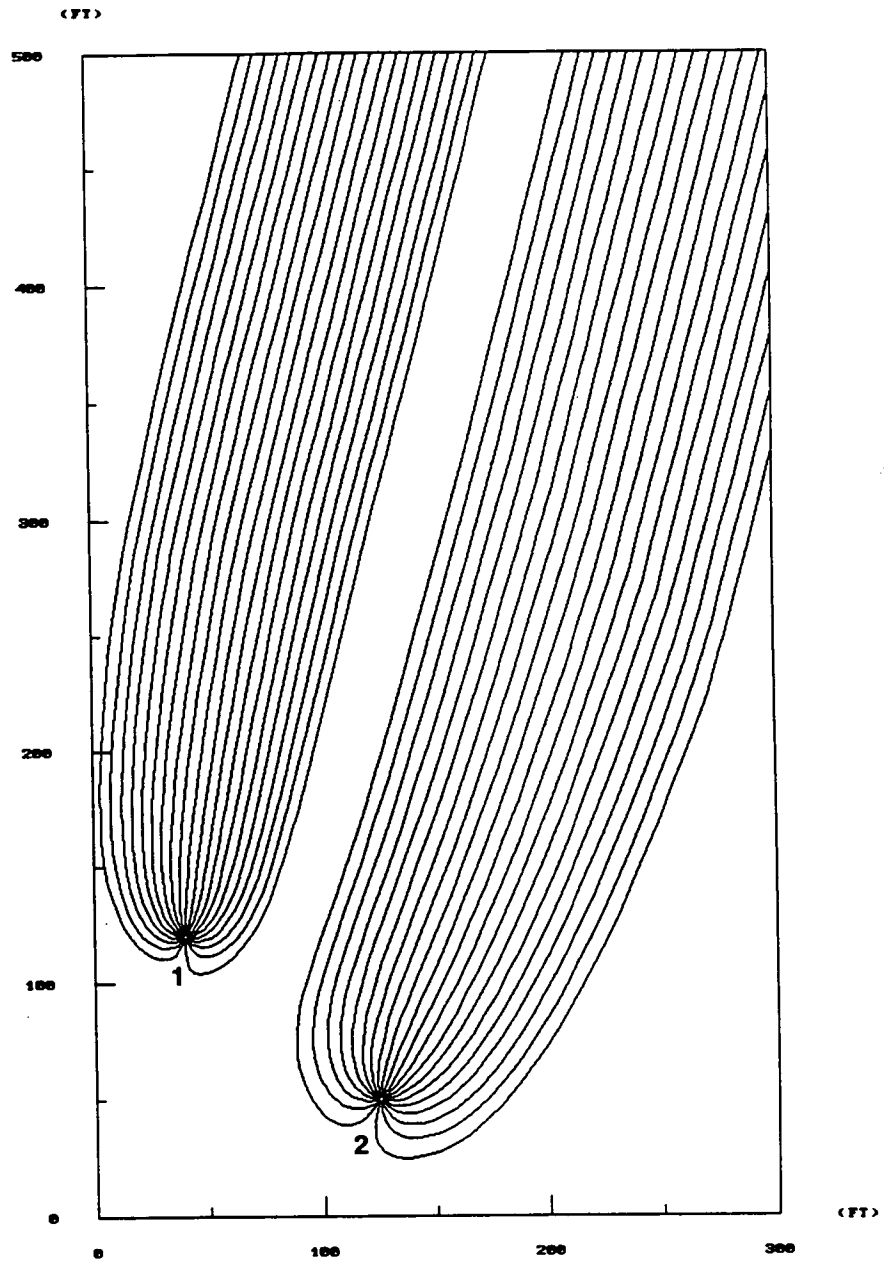
Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0008
saturated thickness = 12 ft
flow direction = N-S

Figure E.13. Capture zones with hydraulic gradient of 0.0008.



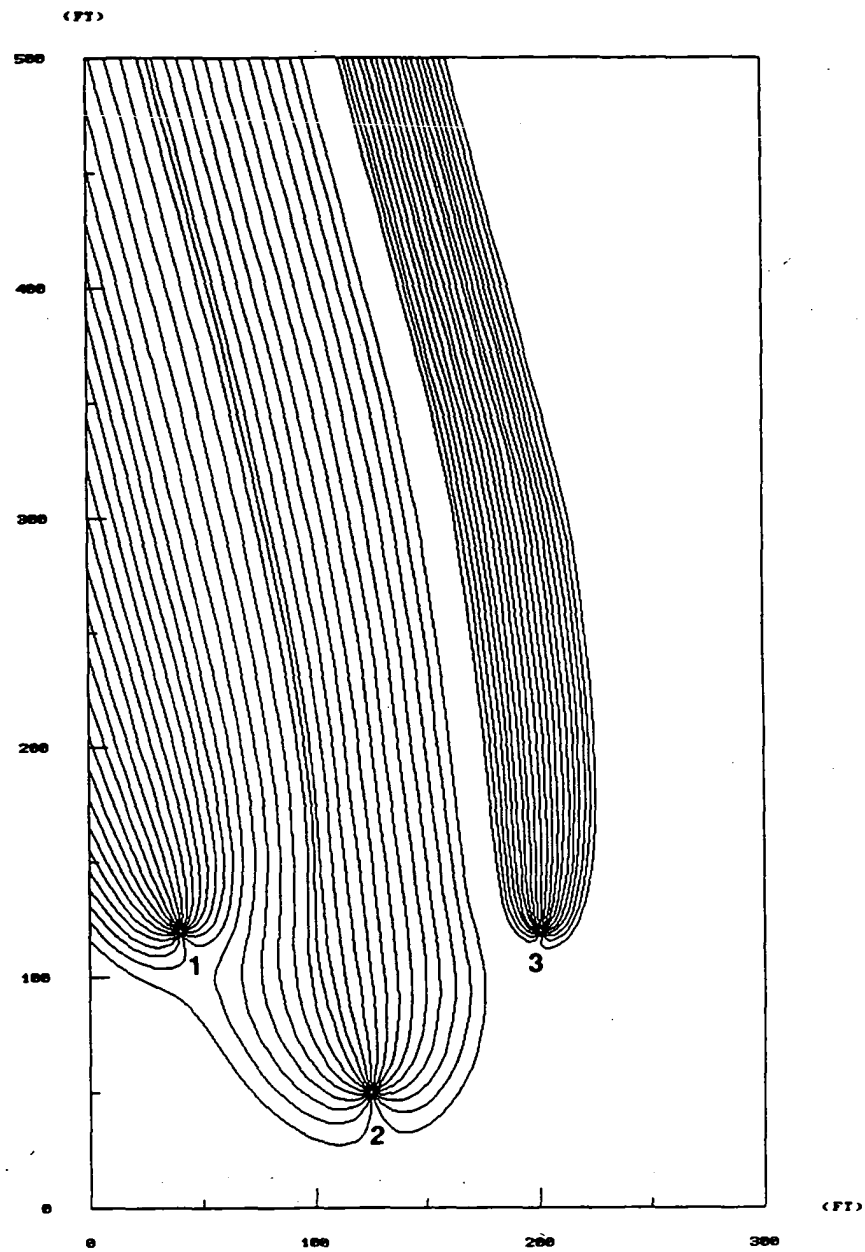
Well No. 1 @ 25 gpm
Well No. 2 @ 25 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.003
saturated thickness = 12 ft
flow direction = N-S

Figure E.14. Capture zones with hydraulic gradient of 0.003.



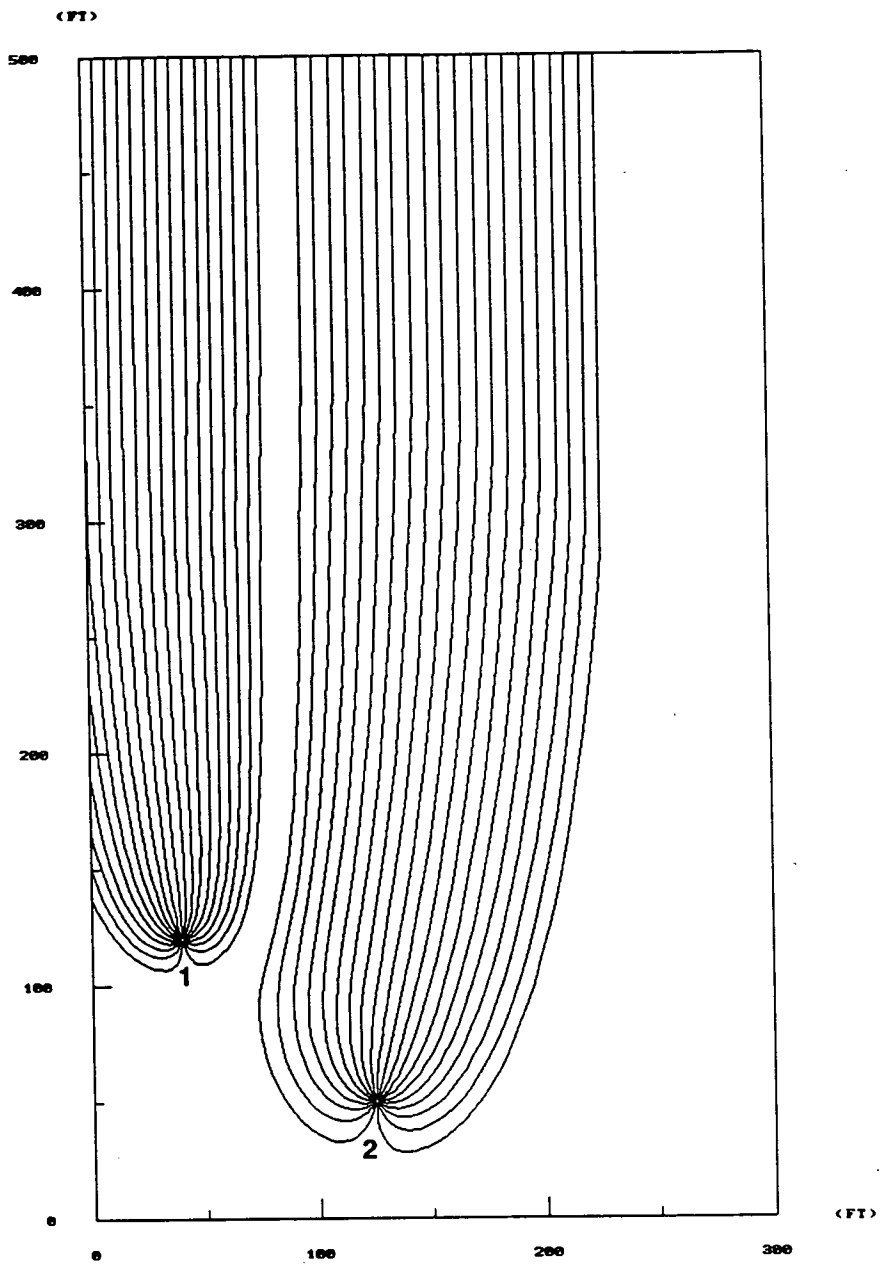
Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0008
saturated thickness = 12 ft
flow direction = S 15° W

Figure E.15. Capture zones with ambient groundwater flow south 15° east.



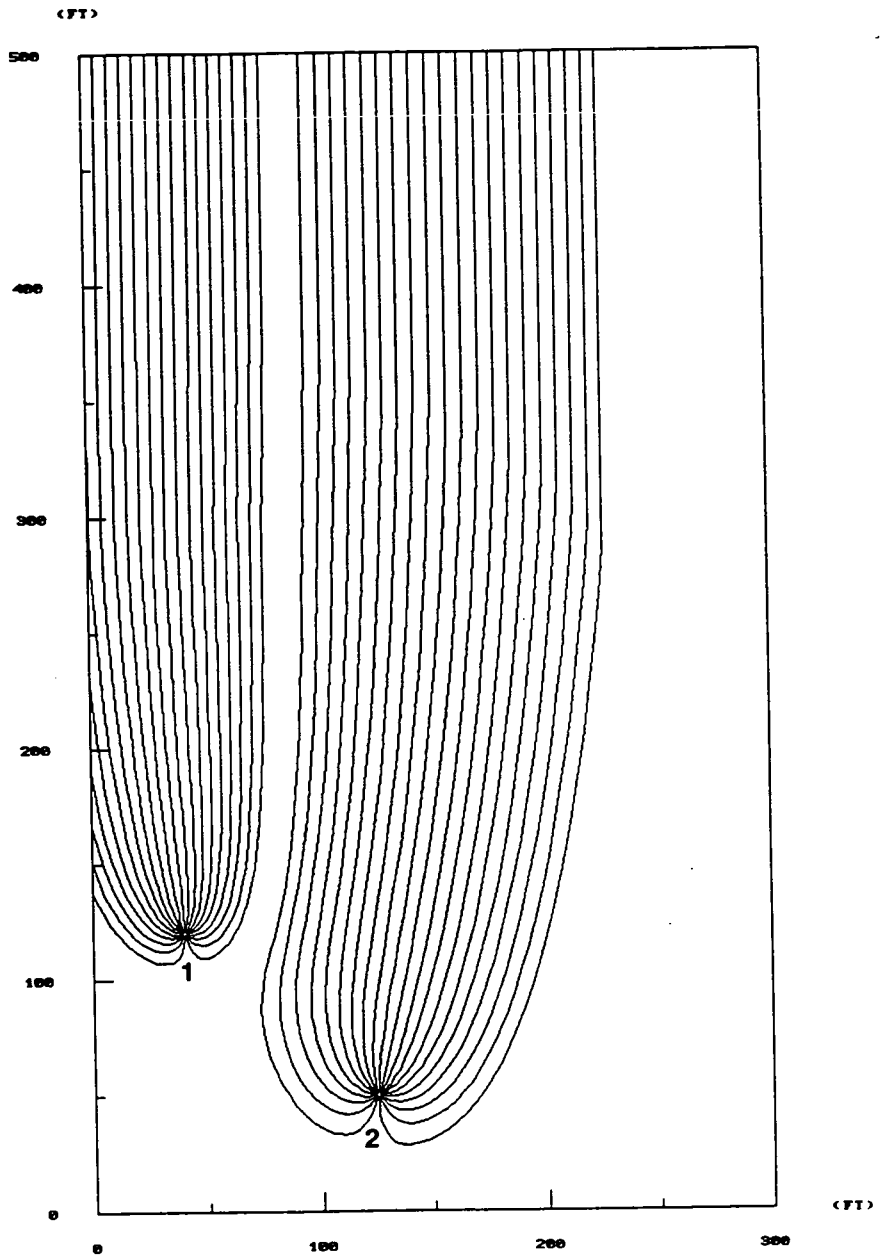
Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
Well No. 3 @ 10 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0008
saturated thickness = 12 ft
flow direction = S 15° E

Figure E.16. Capture zones with ambient groundwater flow south 15° west.



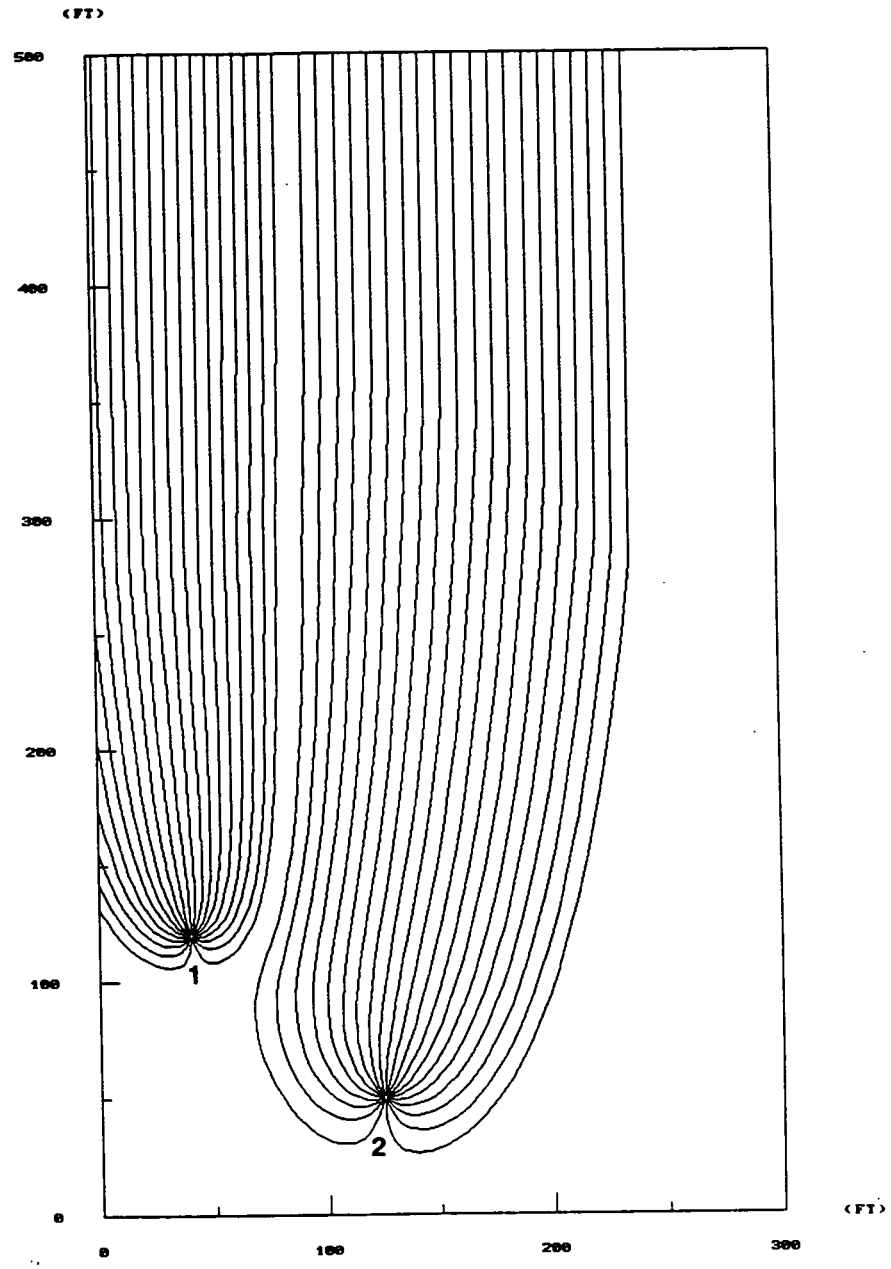
Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0008
saturated thickness = 8 ft
flow direction = N-S

Figure E.17. Capture zones with saturated thickness of 8 feet.



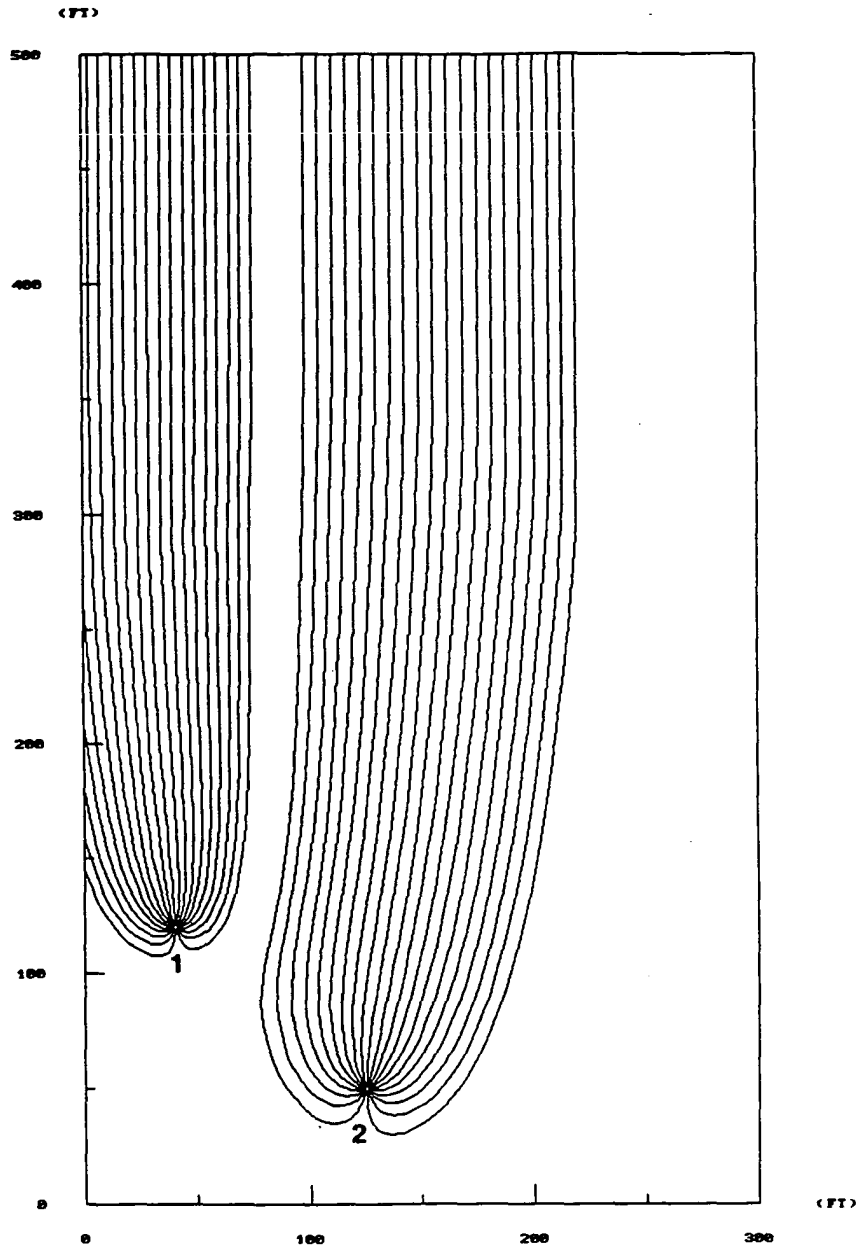
Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 36,500 ft^2/day
gradient = 0.0008
saturated thickness = 16 ft
flow direction = N-S

Figure E.18. Capture zones with saturated thickness of 16 feet.



Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 33,000 ft^2/day
gradient = 0.0008
saturated thickness = 12 ft
flow direction = N-S

Figure E.19. Capture zones with transmissivity of 33,000 ft^2/day.



Well No. 1 @ 20 gpm
Well No. 2 @ 25 gpm
transmissivity = 40,000 ft^2/day
gradient = 0.0008
saturated thickness = 12 ft
flow direction = N-S

Figure E.20. Capture zones with transmissivity of 40,000 ft^2/day.

E2. TRAVEL TIME CALCULATION

E2.1. OBJECTIVE

This calculation determined the length of time for tetrachloroethene to travel along a groundwater flow path within a recovery well capture zone from a suspected source area to the recovery well. Tetrachloroethene (PCE) was used in the calculation because it has the highest organic carbon partition coefficient of all of the volatile organic compound (VOC) contaminants of concern (COCs). Therefore, the calculation resulted in the most conservative VOC travel time estimate.

E2.2. METHOD

The methodology employed for this calculation came from "Basics of Pump-and-Treat Ground-Water Remediation Technology" (EPA, 1990). Interstitial groundwater velocity was calculated for a given extraction rate. The retardation factor was calculated using site-specific organic carbon content, aquifer bulk density, effective porosity, and organic carbon partition coefficient for PCE. A travel distance was determined between the northern boundary of potential contaminant source areas and a groundwater recovery well location for a given flow line. The interstitial groundwater velocity was divided by the retardation coefficient to obtain contaminant migration velocity. The travel distance was divided by rate of contaminant migration to obtain travel time from one side of the site to the recovery well.

E2.3. HYDROGEOLOGIC CHARACTERISTICS AND CONTAMINANT PROPERTIES

The hydrogeologic characteristics and PCE contaminant properties used in the calculations are listed in Table E.4. The source of this data is from the Operable Unit 1 RIR (DOE 1994a). The pumping rate and length of flow path used in this calculation is from Part 1 of this appendix. The flow path is from beneath the overflow pond to the proposed recovery well location south of Area B (Figure A-8A).

Table E.4. PCE Contaminant Properties and Hydrogeologic Characteristics

Property	Value
pumping rate	20 gpm[a]
flow path length	350 ft[a]
average aquifer thickness	16 ft[a]
effective porosity	0.25[b]
organic carbon partition coefficient (K_{oc})	238[b]
percent organic matter	0.016[b]
bulk density	1.9 gm/cm^3 [b]

[a]information from Appendix E, Section 1.
[b]information from Operable Unit 1 Remedial Investigation Report (DOE 1994).

E2.4. CALCULATIONS

Interstitial groundwater velocity at 20 gpm

Convert extraction rate in gpm to ft^3/yr:

(20 gal/min)(1440 min/day)(1 ft^3/7.48 gal)(365 days/yr)

= 1,405,348 ft^3/yr

Interstitial area along flow path (unit width):

(flow path length)(aquifer thickness)(effective porosity)

= (350 ft)(16 ft)(0.25)

= 1400 ft^2

(extraction rate)/(flow area)

= (1,405,368 ft^3/yr)/(1400 ft^2)

= 1004 ft/yr

Retardation Coefficient (R_d)

Partition coefficient = (K_{oc})(percent organic matter)

K_d = (238)(0.016) = 3.8

R_d = 1 + (Pd/n)(K_d)

where, Pd = bulk density

n = effective porosity

R_d = 1 + (1.9/0.25)(3.8) = 29.9

Tetrachloroethene velocity:

(groundwater velocity)/(R_d)

= (1004 ft/yr)/(29.9) = 33.6 ft/yr

Contaminant travel time:

(flow path length)/(PCE velocity)

= (350 ft)/(33.6 ft/yr) = 10.4 years

Groundwater travel time:

(350 ft)/(1004 ft/yr)

= 0.35 years = 4 months

E2.5. RESULTS

The travel time of PCE from the furthest suspected source area to the recovery well south of Area B is estimated to be approximately 10 years. This travel time is approximately 30 times longer than the estimated travel time for groundwater over the same distance. Additional source input along the flow path was neglected, and the kinetics of adsorption/desorption was also neglected.

E2.6. ESTIMATED DURATION OF REMEDY

In principle, the duration of the remedy is indeterminate. That is, the length of time that groundwater must be withdrawn before the site is "clean" cannot be accurately calculated. Additional, detailed information on site stratigraphy would allow more elaborate hydraulic modeling of the groundwater regime. However, uncertainties associated with the source term and contaminant adsorption during transport would continue to make any predictions of the remedial action lifetime unreliable. Therefore, the most appropriate forecast of duration is one or more simplified calculations that can be used to bound the problem.

The first calculation, to provide a credible lower bound, is, in fact, the calculation provided in Section E2.4, above. The travel time for PCE across the site is calculated to be about 10 years. This travel time can be taken as a forecast of the minimum time for site cleanup, without taking into account original concentrations. Only plug flow time for a given withdrawal rate and a retardation coefficient were considered.

A second method of calculation considers the aquifer volume, V, under Area B to be a well-mixed container undergoing continuous dilution. The outflow (discharge, Q) concentration is equal to the average concentration and the inflow is contaminant free. The average concentration in the zone of interest is described by the infinite dilution equation

$$C = C_o e^{-\lambda t}$$

where lambda (λ) = $Q/(V*R_d)$

Noting that a reduction in VOC concentration of three orders of magnitude would result in a residual risk of less that $1x10^{-6}$. By adopting the same parameters as in Section E.2, we can compute a time to reach the target reduction.

By letting

Q = 20 gpm

V = $1.55x10^6$ gallons [from Appendix B]

R_d = 30

and setting the ratio of the final to the initial concentration

$C/C_o = 10^{-3}$,

substitution yields

t = 30 years.

This calculation is taken as a credible maximum likelihood estimate of the duration of the active pumping. It is not a good estimate of the possible maximum duration, which may be much longer (or shorter).

E3. REFERENCES

DOE. 1992. Remedial Investigation/Feasibility Study, Operable Unit 9, Site Scoping Report: Volume 2 - Geologic Log and Well Information Report. Environmental Restoration Program, U. S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. May 1992.

DOE. 1994a. Operable Unit 1 Remedial Investigation Report, Mound Plant, Miamisburg, Ohio, Volume 1 - Text, [Draft Final] (Revision 1). Environmental Restoration Program, U. S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. March 1994.

DOE. 1994b. "Remedial Investigation/Feasibility Study, Operable Unit 9, Hydrogeologic Investigation Well Information Report [DRAFT]." Environmental Restoration Program, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. January 1994.

EPA. 1990. Basics of Pump-and-Treat Ground-Water Remediation Technology. U.S. Environmental Protection Agency, Environmental Research Laboratory. EPA/600/8-90/003. March 1990.

EPA. 1993. Well Head Protection Area Delineation code. U.S. Environmental Protection Agency, Office of Groundwater Protection. April 1993.

APPENDIX F

DETAILED ANALYSIS COST ESTIMATES

F1. DETAILED ANALYSIS COST ESTIMATES

F2. REFERENCES

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ACRONYM LIST

O&M	operation and maintenance
CORA	Cost of Remedial Action

F1. DETAILED ANALYSIS COST ESTIMATES

This appendix presents the cost estimates for the nine alternatives that were retained and presented in Section 4. The costs for each alternative are summarized in Table F.1 and include the total capital cost; the annual operation and maintenance (O&M) cost; present value of the 30-year O&M cost; and the total value. Note that the costs associated with Alternative 2 represent the costs common to the subsequent alternatives. Tables F.2 through F.17 are worksheets that show the details of the cost analysis.

F1.1. CAPITAL COSTS

Capital costs consist of direct and indirect capital and are those expenditures required to initiate and install a remedial action. Direct capital includes those expenditures, generally incurred during the first year, that are necessary for construction and installation of the remedial action. Direct capital includes

- remedial action costs,
- component equipment,
- land and site development,
- buildings and services, and
- disposal costs.

Indirect capital includes engineering, contingency, and miscellaneous legal and permitting costs.

F1.2. OPERATION AND MAINTENANCE COSTS

O&M costs are those post-construction costs necessary to ensure the continued effectiveness of remedial construction. Components of operation and maintenance include

- operating labor,
- maintenance materials and labor,
- auxiliary materials and energy,
- purchased services,
- administrative costs,
- insurance, taxes, and licenses,
- contingency, and
- miscellaneous.

F1.3. PRESENT VALUE OF THE 30-YEAR ANNUAL OPERATION AND MAINTENANCE

The present worth cost represents the amount of money that, if invested in Year 0 and disbursed as needed on an annual basis, would be sufficient to cover all costs associated with a remedial alternative. Because the life span of each alternative was considered to be the same, a period of thirty years was used for the cost analysis, and an interest rate of 3.2% was assumed. This rate is the anticipated economic escalation rate (Environmental Restoration Program) for out year 1996 (Pearman 1994). These values were used in the following equation (Au 1983):

$$P = U\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

where:

P = present value
U = uniform cost
n = number of periods
i = interest rate

The disposal costs were not estimated because it was assumed that all disposal of soils, whether from drilling or installation of the vertical barrier, would be processed through the Mound Plant Investigation-derived material program (DOE 1994).

The Cost of Remedial Action (CORA) estimating program was used for estimating the costs associated with the surface cap. Problems that exist for estimating the cap costs include material and engineering design. The geotechnical properties and availability of engineered materials required for the cap is uncertain. The cap proposed for these alternatives would augment the existing cap for the present site sanitary landfill. Uncertainty also exists in the engineering and design requirements for merging the two caps. The same cost estimate for the surface cap, however, was used in each alternative that included capping as a technology type.

In compiling the cost estimate in this appendix, the following sources were used:

- vendor-specific information,
- Remedial Action Costing Procedures Manual by B. Burgher, M. Culpepper, and W. Zieger, prepared for U. S Environmental Protection Agency, EPA/600/S-87/049, October, 1987,

- Means Site Work Cost Data, 1990, 9th Annual Edition by R. S. Means Company, Inc., Construction Consultants and Publishers, P.O. Box 800, Kingston, MA, 02364-0800, and

- Means Heavy Construction Cost Data, 1994, 8th Annual Edition by R. S. Means Company, Inc., Construction Consultants and Publishers, P.O. Box 800, Kingston, MA, 02364-0800.

Table F.1. Summary of Detailed Cost Analysis

Alternative Number	Short Title	Total Capital Cost[a] (TCC)	Annual Operation and Maintenance without Common Cost[a]	Present Value of 30-yr Annual Operation and Maintenance without Common Cost[a]	Total Present Value without Common Cost[a]
1	No Action	$0	$0	$0	$0
2	Institutional Action	$139,000	$201,000	$3,840,000	$3,980,000
Each of the following entries is IN ADDITION TO the cost shown for line 2 (Alternative 2).					
3	Collect/Disposal	$205,000	$3,000	$57,300	$262,000
4	Collect/Treat/Disposal	$567,000	$61,000	$1,170,000	$1,740,000
5	Collect/Treat/Disposal/Cap	$857,000	$80,000	$1,530,000	$2,390,000
6	Cont/Collect/Treat/Disposal	$1,330,000	$69,000	$1,320,000	$2,650,000
7	Cont/Collect/Treat/Disposal/Cap	$1,620,000	$88,000	$1,680,000	$3,300,000
8	*In situ* GW Treatment	$1,650,000	$17,000	$325,000	$1,980,000
9	*In situ* GW Treatment/Cap	$1,940,000	$36,000	$688,000	$2,630,000

a - represents the common cost used in each cost estimate
Figures rounded to three significant digits after computations completed

TABLE F.2. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 2

ALTERNATIVE 2
Instituional Action
Monitoring

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling; 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Total Direct Costs (TDC)					$99,603
INDIRECT CAPITAL COSTS	1. Engineering and Design				10% of TDC	$9,960
	2. Contingency Allowance				20% of TCC	$27,737
	3. Other Inderect Costs: (legal fees, permits, etc.)				1% of TCC	$1,387
	Total Indirect Costs					$39,084
TOTAL CAPITAL COSTS (TCC)						$138,687

TABLE F.3. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 2

ALTERNATIVE 2
Institutional Action
Monitoring

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY	YEAR	ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
	Total O & M cost								$54,363
2. MAINTENANCE									
Material & labor	Dedicated pumps		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Total Maintenance, Materials and Labor								$1,100
3. PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$1,387	1	1-30	$1,387
TOTAL ANNUAL OPERATING COSTS									$200,850

TABLE F.4. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 3

ALTERNATIVE 3
Institutional Action
Collection
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling; 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Extraction Wells	Install 2 groundwater extraction wells					
Materials:	Drilling; 12-in diameter borehole (incl drill crew labor/material/epuip)	100	FT	$50.00		$5,000
	8-in water well casing (incl. grout)	70	FT	$24.00		$1,680
	8-in water well screen riser	30	FT	$55.00		$1,650
	Filter pack, silica sand	40	FT	$8.00		$320
	Bentonite seal	4	FT	$35.00		$140

TABLE F.4. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 3

ALTERNATIVE 3
Instituional Action
Collection
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Protective case with locking cap	2	WELL	$600.00		$1,200
	Development (4hr/well)	8	HR	$60.00		$480
	Decontamination of equipment (4hr/well)	8	HR	$135.00		$1,080
	Site preparation	2	WELL	$100.00		$200
	Mob/demob		LS			$1,200
	55-gal drum (DOT 17E)	30	DRUM	$30.00		$900
	2,000-gal poly tank	2	TANK	$300.00		$600
	Staging drums (2hr/well)	4	HR	$40.00		$160
	Perdiem, drill crew (4 crew members, 6 days)	24	MAN-DAY	$60.00		$1,440
Labor:	Engineer, general	48	HR	$69.83		$3,352
	Perdiem, engineer	6	DAY	$93.00		$558
	Geologist	48	HR	$57.86		$2,777
	Perdiem,geologist	6	DAY	$93.00		$558
	Car rental (one car, engineer and geologist)	6	DAY	$39.41		$236
Pump installation	Install pumps in extraction wells					
Materials:	2-in pvc in trench	1500	LF	$3.00		$4,500
	Electrical hook-up	2	WELL	$500.00		$1,000
	Control box		LS			$5,000
Labor:	Hook-up, start-up (8HR/WELL)	16	WELL	$40.24		$644
Ditch lining	Lining existing ditches with concrete					
Materials:	Concrete installed (incl. mat/lab/equip)	17850	SF	$3.64		$64,974
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Extraction pumps	2	PUMP	$1,170.00		$2,340
	Total Direct Costs (TDC)					$201,593
INDIRECT CAPITAL COSTS	1. Engineering and Design				10% of TDC	$20,159
	2. Contingency Allowance				20% of TCC	$68,798
	3. Other Inderect Costs:				NPDES Permit	$50,000
	(legal fees, permits, etc.)				1% of TCC	$3,440
	Total Indirect Costs					$142,397
TOTAL CAPITAL COSTS (TCC)						$343,990

TABLE F.5. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 3

ALTERNATIVE 3
Institutional Action
Collection
Disposal

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY	YEAR	ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem,geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
	Total O & M cost								$54,363
2. MAINTENANCE									
Material & labor	Dedicated pumps, sampling		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Ditch Maintenance (incl labor/equip)	1	MOWING	$400.00		$400.00	2	1-30	$800
	Equipment Maintenance: extraction pumps	1	LS		3% of purchase price	$70.00	1	1-30	$70
	Total Maintenance, Materials and Labor								$1,970
3. AUXILLARY									
Material & labor	Power, pumps	6532	KW-HR	$0.06		$391.92	1	1-30	$392
									$392
4. PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$3,440	1	1-30	$3,440
TOTAL ANNUAL OPERATING COSTS									$204,165

TABLE F.6. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 4

ALTERNATIVE 4
Institutional Action
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling; 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Extraction Wells	Install 2 groundwater extraction wells					
Materials:	Drilling; 12-in diameter borehole (incl drill crew labor/material/epuip)	100	FT	$50.00		$5,000
	8-in water well casing (incl. grout)	70	FT	$24.00		$1,680
	8-in water well screen riser	30	FT	$55.00		$1,650
	Filter pack, silica sand	40	FT	$8.00		$320
	Bentonite seal	4	FT	$35.00		$140

TABLE F.6. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 4

ALTERNATIVE 4
Institutional Action
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Protective case with locking cap	2	WELL	$600.00		$1,200
	Development (4hr/well)	8	HR	$60.00		$480
	Decontamination of equipment (4hr/well)	8	HR	$135.00		$1,080
	Site preparation	2	WELL	$100.00		$200
	Mob/demob		LS			$1,200
	55-gal drum (DOT 17E)	30	DRUM	$30.00		$900
	2,000-gal poly tank	2	TANK	$300.00		$600
	Staging drums (2hr/well)	4	HR	$40.00		$160
	Perdiem, drill crew (4 crew members, 6 days)	24	MAN-DAY	$60.00		$1,440
Labor:	Engineer, general	48	HR	$69.83		$3,352
	Perdiem, engineer	6	DAY	$93.00		$558
	Geologist	48	HR	$57.86		$2,777
	Perdiem,geologist	6	DAY	$93.00		$558
	Car rental (one car, engineer and geologist)	6	DAY	$39.41		$236
Pump installation	Install pumps in extraction wells					
Materials:	2-in pvc in trench	1500	LF	$3.00		$4,500
	Electrical hook-up	2	WELL	$500.00		$1,000
	Control box		LS			$5,000
Labor:	Hook-up, start-up (8HR/WELL)	16	WELL	$40.24		$644
Ditch lining	Lining existing ditches with concrete					
Materials:	Concrete installed (incl. mat/lab/equip)	17850	SF	$3.64		$64,974
Aboveground treatment	Install UV/oxidation Unit					
Labor:	Installation by factory rep.	40	HR	$70.00		$2,800
	Training	8	HR	$70.00		$560
	Perdiem	6	DAY	$93.00		$558
	Car rental	6	DAY	$39.41		$236
	Treatability study in lab (prior to installation)		LS			$3,500
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Extraction pumps	2	PUMP	$1,170.00		$2,340
	UV/Oxidation unit		LS			$245,000
3. Buildings and Service	Building for treatment unit	1	BLDG	$6,785.00		$6,785
	Foundation for building (concrete in place)	144	SF	$3.64		$524
	Total Direct Costs (TDC)					$461,556

TABLE F.6. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 4

ALTERNATIVE 4
Instituional Action
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
INDIRECT CAPITAL COSTS						
	1. Engineering and Design				10% of TDC	$46,157
	2. Contingency Allowance				20% of TCC	$141,196
	3. Other Inderect Costs:				NPDES Permit	$50,000
	(legal fees, permits, etc.)				1% of TCC	$7,060
	Total Indirect Costs					$244,413
TOTAL CAPITAL COSTS (TCC)						$705,969

TABLE F.7. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 4

ALTERNATIVE 4
Institutional Action
Collection
Treatment
Disposal

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY	YEAR	ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
Pump/Treat system	Plant Skilled Labor (2 hours per day)	730	HR	40.24		$29,375	1	1-30	$29,375
	Total O & M cost								$83,738
2. MAINTENANCE									
Material & labor	Dedicated pumps, sampling		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Ditch Maintenance (incl labor/equip)	1	MOWING	$400.00		$400.00	2	1-30	$800
	Equipment Maintenance: extraction pumps, UV/OX unit	1	LS		3% of purchase price	$7,400.00	1	1-30	$7,400
	Total Maintenance, Materials and Labor								$9,300
3. AUXILLARY									
Material & labor	Power, pumps	6532	KW-HR	$0.06		$391.92	1	1-30	$392
	UV/OX, power/chemicals	57.6	1000 x gpd	$0.84		$48.38	365	1-30	$17,660
									$18,052
4. PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$7,060	1	1-30	$7,060
TOTAL ANNUAL OPERATING COSTS									$262,150

TABLE F.8. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 5

ALTERNATIVE 5
Instituional Action
Surface Cap
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling: 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Extraction Wells	Install 2 groundwater extraction wells					
Materials:	Drilling: 12-in diameter borehole (incl drill crew labor/material/epuip)	100	FT	$50.00		$5,000
	8-in water well casing (incl. grout)	70	FT	$24.00		$1,680
	8-in water well screen riser	30	FT	$55.00		$1,650
	Filter pack, silica sand	40	FT	$8.00		$320

TABLE F.8. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 5

ALTERNATIVE 5
Institutional Action
Surface Cap
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Bentonite seal	4	FT	$35.00		$140
	Protective case with locking cap	2	WELL	$600.00		$1,200
	Development (4hr/well)	8	HR	$60.00		$480
	Decontamination of equipment (4hr/well)	8	HR	$135.00		$1,080
	Site preparation	2	WELL	$100.00		$200
	Mob/demob		LS			$1,200
	55-gal drum (DOT 17E)	30	DRUM	$30.00		$900
	2,000-gal poly tank	2	TANK	$300.00		$600
	Staging drums (2hr/well)	4	HR	$40.00		$160
	Perdiem, drill crew (4 crew members, 6 days)	24	MAN-DAY	$60.00		$1,440
Labor:	Engineer, general	48	HR	$69.83		$3,352
	Perdiem, engineer	6	DAY	$93.00		$558
	Geologist	48	HR	$57.86		$2,777
	Perdiem,geologist	6	DAY	$93.00		$558
	Car rental (one car, engineer and geologist)	6	DAY	$39.41		$236
Pump installation	Install pumps in extraction wells					
Materials:	2-in pvc in trench	1500	LF	$3.00		$4,500
	Electrical hook-up	2	WELL	$500.00		$1,000
	Control box		LS			$5,000
Labor:	Hook-up, start-up (8HR/WELL)	16	WELL	$40.24		$644
Ditch lining	Lining existing ditches with concrete					
Materials:	Concrete installed (incl. mat/lab/equip)	17850	SF	$3.64		$64,974
Aboveground treatment	Install UV/oxidation Unit					
Labor:	Installation by factory rep.	40	HR	$70.00		$2,800
	Training	8	HR	$70.00		$560
	Perdiem	6	DAY	$93.00		$558
	Car rental	6	DAY	$39.41		$236
	Treatability study in lab (prior to installation)		LS			$3,500
Low permeability soil cap	Install Soil Cap (incl. mat/lab/equip)				CORA estimate	$208,300
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Extraction pumps	2	PUMP	$1,170.00		$2,340
	UV/Oxidation unit		LS			$245,000
3. Buildings and Service	Building for treatment unit	1	BLDG	$6,785.00		$6,785

TABLE F.8. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 5

ALTERNATIVE 5
Instituional Action
Surface Cap
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Foundation for building (concrete in place)	144	SF	$3.64		$524
	Total Direct Costs (TDC)					$669,856
INDIRECT CAPITAL COSTS	1. Engineering and Design				10% of TDC	$66,986
	2. Contingency Allowance				20% of TCC	$199,201
	3. Other Inderect Costs:				NPDES Permit	$50,000
	(legal fees, permits, etc.)				1% of TCC	$9,960
	Total Indirect Costs					$326,147
TOTAL CAPITAL COSTS (TCC)						$996,003

TABLE F.9. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 5

ALTERNATIVE 5
Institutional Action
Surface Cap
Collection
Treatment
Disposal

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY	YEAR	ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
Pump/Treat system									
	Plant Skilled Labor (2 hours per day)	730	HR	40.24		$29,375	1	1-30	$29,375
	Total O & M cost								$83,738
2. MAINTENANCE									
Material & labor	Dedicated pumps, sampling		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Cap inspect/maint				CORA est.		1	1-30	$16,000
	Ditch Maintenance (incl labor/equip)	1	MOWING	$400.00		$400.00	2	1-30	$800
	Equipment Maintenance: extraction pumps, UV/OX unit	1	LS		3% of purchase price	$7,400.00	1	1-30	$7,400
	Total Maintenance, Materials and Labor								$25,300
3. AUXILLARY									
Material & labor	Power, pumps	6532	KW-HR	$0.06		$391.92	1	1-30	$392
	UV/OX, power/chemicals	57.6	1000 x gpd	$0.84		$49.38	365	1-30	$17,660
									$18,052
4. PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$9,960	1	1-30	$9,960
TOTAL ANNUAL OPERATING COSTS									$281,050

TABLE F.10. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 6

ALTERNATIVE 6
Instituional Action
Containment
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling; 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Extraction Wells	Install 4 groundwater extraction wells					
Materials:	Drilling; 12-in diameter borehole (incl drill crew labor/material/epuip)	200	FT	$50.00		$10,000
	8-in water well casing (incl. grout)	140	FT	$24.00		$3,360
	8-in water well screen riser	60	FT	$55.00		$3,300
	Filter pack, silica sand	80	FT	$8.00		$640

TABLE F.10. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 6

ALTERNATIVE 6
Institutional Action
Containment
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Bentonite seal	8	FT	$35.00		$280
	Protective case with locking cap	4	WELL	$600.00		$2,400
	Development (4hr/well)	16	HR	$60.00		$960
	Decontamination of equipment (4hr/well)	16	HR	$135.00		$2,160
	Site preparation	4	WELL	$100.00		$400
	Mob/demob		LS			$1,200
	55-gal drum (DOT 17E)	60	DRUM	$30.00		$1,800
	2,000-gal poly tank	2	TANK	$300.00		$600
	Staging drums (2hr/well)	8	HR	$40.00		$320
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Pump installation	Install pumps in extraction wells					
Materials:	2-in pvc in trench	2000	LF	$3.00		$6,000
	Electrical hook-up	4	WELL	$500.00		$2,000
	Control box		LS			$5,000
Labor:	Hook-up, start-up (8HR/WELL)	32	WELL	$40.24		$1,288
Ditch lining	Lining existing ditches with concrete					
Materials:	Concrete installed (incl. mat/lab/equip)	17850	SF	$3.64		$64,974
Aboveground treatment	Install UV/oxidation Unit					
Labor:	Installation by factory rep.	40	HR	$70.00		$2,800
	Training	8	HR	$70.00		$560
	Perdiem	6	DAY	$93.00		$558
	Car rental	6	DAY	$39.41		$236
	Treatability study in lab (prior to installation)		LS			$3,500
Containment	Install slurry columns, 800-ft long to bedrock					
Labor:	Installation (incl mat/equip/labor)	45496	VSF	$7.50		$341,220
	Mob/demob		LS			$180,000
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Extraction pumps	4	PUMP	$1,170.00		$4,680

TABLE F.10. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 6

ALTERNATIVE 6
Instituional Action
Containment
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	UV/Oxidation unit		LS			$245,000
3. Buildings and Service	Building for treatment unit	1	BLDG	$6,785.00		$6,785
	Foundation for building (concrete in place)	144	SF	$3.64		$524
	Total Direct Costs (TDC)					$1,009,992
INDIRECT CAPITAL COSTS	1. Engineering and Design				10% of TDC	$100,999
	2. Contingency Allowance				20% of TCC	$293,922
	3. Other Inderect Costs:				NPDES Permit	$50,000
	(legal fees, permits, etc.)				1% of TCC	$14,696
	Total Indirect Costs					$459,617
TOTAL CAPITAL COSTS (TCC)						$1,469,609

TABLE F.11. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 6

ALTERNATIVE 6
Institutional Action
Containment
Collection
Treatment
Disposal

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY/YEAR		ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem,geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
Pump/Treat system	Plant Skilled Labor (2 hours per day)	730	HR	40.24		$29,375	1	1-30	$29,375
	Total O & M cost								$83,738
2. MAINTENANCE									
Material & labor	Dedicated pumps, sampling		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Ditch Maintenance (incl labor/equip)	1	MOWING	$400.00		$400.00	2	1-30	$800
	Equipment Maintenance: extraction pumps, UV/OX unit	1	LS		3% of purchase price	$7,500.00	1	1-30	$7,500
	Total Maintenance, Materials and Labor								$9,400
3. AUXILLARY									
Material & labor	Power, pumps	13064	KW-HR	$0.06		$783.84	1	1-30	$784
	UV/OX, power/chemicals	57.6	1000 x gpd	$0.84		$48.38	365	1-30	$17,660
									$18,444
4 PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$14,696	1	1-30	$14,696
TOTAL ANNUAL OPERATING COSTS									$270,278

TABLE F.12. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 7

ALTERNATIVE 7
Institutional Action
Surface Cap
Containment
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling: 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Extraction Wells	Install 4 groundwater extraction wells					
Materials:	Drilling: 12-in diameter borehole (incl drill crew labor/material/epuip)	200	FT	$50.00		$10,000
	8-in water well casing (incl. grout)	140	FT	$24.00		$3,360
	8-in water well screen riser	60	FT	$55.00		$3,300
	Filter pack, silica sand	80	FT	$8.00		$640

TABLE F.12. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 7

ALTERNATIVE 7
Institutional Action
Surface Cap
Containment
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Bentonite seal	8	FT	$35.00		$280
	Protective case with locking cap	4	WELL	$600.00		$2,400
	Development (4hr/well)	16	HR	$60.00		$960
	Decontamination of equipment (4hr/well)	16	HR	$135.00		$2,160
	Site preparation	4	WELL	$100.00		$400
	Mob/demob		LS			$1,200
	55-gal drum (DOT 17E)	60	DRUM	$30.00		$1,800
	2,000-gal poly tank	2	TANK	$300.00		$600
	Staging drums (2hr/well)	8	HR	$40.00		$320
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Pump installation	Install pumps in extraction wells					
Materials:	2-in pvc in trench	2000	LF	$3.00		$6,000
	Electrical hook-up	4	WELL	$500.00		$2,000
	Control box		LS			$5,000
Labor:	Hook-up, start-up (8HR/WELL)	32	WELL	$40.24		$1,288
Ditch lining	Lining existing ditches with concrete					
Materials:	Concrete installed (incl. mat/lab/equip)	17850	SF	$3.64		$64,974
Aboveground treatment	Install UV/oxidation Unit					
Labor:	Installation by factory rep.	40	HR	$70.00		$2,800
	Training	8	HR	$70.00		$560
	Perdiem	6	DAY	$93.00		$558
	Car rental	6	DAY	$39.41		$236
	Treatability study in lab (prior to installation)		LS			$3,500
Containment	Install slurry columns, 800-ft long to bedrock					
Labor:	Installation (incl mat/equip/labor)	45496	VSF	$7.50		$341,220
	Mob/demob		LS			$180,000
Low permeability soil cap	Install Soil Cap (incl. mat/labor/equip)				CORA estimate	$208,300

TABLE F.12. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 7

ALTERNATIVE 7
Instituional Action
Surface Cap
Containment
Collection
Treatment
Disposal

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Extraction pumps	4	PUMP	$1,170.00		$4,680
	UV/Oxidation unit		LS			$245,000
3. Buildings and Service	Building for treatment unit	1	BLDG	$6,785.00		$6,785
	Foundation for building (concrete in place)	144	SF	$3.64		$524
	Total Direct Costs (TDC)					$1,218,292
INDIRECT CAPITAL COSTS	1. Engineering and Design				10% of TDC	$121,829
	2. Contingency Allowance				20% of TCC	$351,929
	3. Other Inderect Costs: (legal fees, permits, etc.)				NPDES Permit	$50,000
					1% of TCC	$17,596
	Total Indirect Costs					$541,354
TOTAL CAPITAL COSTS (TCC)						$1,759,646

TABLE F.13. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 7

ALTERNATIVE 7
Institutional Action
Surface Cap
Containment
Collection
Treatment
Disposal

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY	YEAR	ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
Pump/Treat system	Plant Skilled Labor (2 hours per day)	730	HR	40.24		$29,375	1	1-30	$29,375
	Total O & M cost								$83,738
2. MAINTENANCE									
Material & labor	Dedicated pumps, sampling		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Cap inspect/maint				CORA est.		1	1-30	$16,000
	Ditch Maintenance (incl labor/equip)	1	MOWING	$400.00		$400.00	2	1-30	$800
	Equipment Maintenance: extraction pumps, UV/OX unit	1	LS		3% of purchase price	$7,500.00	1	1-30	$7,500
	Total Maintenance, Materials and Labor								$25,400
3. AUXILLARY									
Material & labor	Power, pumps	13064	KW-HR	$0.06		$783.84	1	1-30	$784
	UV/OX, power/chemicals	57.6	1000 x gpd	$0.84		$48.38	365	1-30	$17,660
									$18,444
4. PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$17,597	1	1-30	$17,597
TOTAL ANNUAL OPERATING COSTS									$289,179

TABLE F.14. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 8

ALTERNATIVE 8
Instituional Action
In-situ Groundwater Treatment

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling: 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Ditch lining	Lining existing ditches with concrete					
Materials:	Concrete installed (incl. mat/lab/equip)	17850	SF	$3.64		$64,974
In-situ Treatment	Install permeable treatment wall					
Labor/Material:	Iron material	528.75	TON	$700.00		$370,125
	Install iron material				60% of iron cost	$222,075
	Impermeable section (by slurry columns)	42652.5	VSF	$7.50		$319,894
	Mob/demob (for slurry column equip)		LS			$180,000

TABLE F.14. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 8

ALTERNATIVE 8
Instituional Action
In-situ Groundwater Treatment

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Bench scale study (prior to installation)		LS			$30,000
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Total Direct Costs (TDC)					$1,286,671
INDIRECT CAPITAL COSTS	1. Engineering and Design				10% of TDC	$128,667
	2. Contingency Allowance				20% of TCC	$358,313
	3. Other Inderect Costs: (legal fees, permits, etc.)				1% of TCC	$17,916
	Total Indirect Costs					$504,896
TOTAL CAPITAL COSTS (TCC)						$1,791,567

TABLE F.15. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 8

ALTERNATIVE 8
Institutional Action
In-situ Groundwater Treatment

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY/YEAR		ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
	Total O & M cost								$54,383
2. MAINTENANCE									
Material & labor	Dedicated pumps, sampling		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Ditch Maintenance (incl labor/equip)	1	MOWING	$400.00		$400.00	2	1-30	$800
	Total Maintenance, Materials and Labor								$1,900
4. PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$17,900	1	1-30	$17,900
TOTAL ANNUAL OPERATING COSTS									$218,163

TABLE F.16. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 9

ALTERNATIVE 9
Instituional Action
Surface Cap
In-situ Groundwater Treatment

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
DIRECT CAPITAL COST:						
1. Construction Cost						
Fencing	Install 8-ft perimeter fence					
Materials:	Installation (incl labor/material/equip)	2200	LF	$17.37		$38,214
Groundwater Monitoring	Install 6 monitoring wells					
Materials:	Drilling: 8-in diameter borehole (incl drill crew labor/material/epuip)	240	FT	$26.00		$6,240
	4-in stainless steel screen	60	FT	$55.00		$3,300
	4-in stainless steel riser	180	FT	$30.00		$5,400
	Filter pack, silica sand	90	FT	$8.00		$720
	Bentonite seal	12	FT	$35.00		$420
	Cement grout	138	FT	$12.00		$1,656
	Protective case with locking cap	6	WELL	$500.00		$3,000
	Development (4hr/well)	24	HR	$60.00		$1,440
	Decontamination of equipment (4hr/well)	24	HR	$135.00		$3,240
	Site preparation	6	WELL	$100.00		$600
	Mob/demob		LS			$600
	55-gal drum (DOT 17E)	50	DRUM	$23.00		$1,150
	2,000-gal poly tank	3	TANK	$300.00		$900
	Staging drums (2hr/well)	12	HR	$40.00		$480
	Construct/remove decon pad		LS			$3,000
	Support facilities (trailer, storage etc.)		LS			$3,000
	Perdiem, drill crew (4 crew members, 12 days)	48	MAN-DAY	$60.00		$2,880
Labor:	Engineer, general	96	HR	$69.83		$6,704
	Perdiem, engineer	12	DAY	$93.00		$1,116
	Geologist	96	HR	$57.86		$5,555
	Perdiem,geologist	12	DAY	$93.00		$1,116
	Car rental (one car, engineer and geologist)	12	DAY	$39.41		$473
Ditch lining	Lining existing ditches with concrete					
Materials:	Concrete installed (incl. mat/lab/equip)	17850	SF	$3.64		$64,974
In-situ Treatment	Install permeable treatment wall					
Labor/Material:	Iron material	528.75	TON	$700.00		$370,125
	Install iron material				60% of iron cost	$222,075
	Impermeable section (by slurry columns)	42652.5	VSF	$7.50		$319,894

TABLE F.16. WORKSHEET FOR CAPITAL COST OF ALTERNATIVE 9

ALTERNATIVE 9
Instituional Action
Surface Cap
In-situ Groundwater Treatment

CAPITAL COST	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)
	Mob/demob (for slurry column equip)		LS			$180,000
	Bench scale study (prior to installation)		LS			$30,000
Low permeability soil cap	Install Soil Cap (incl. mat/labor/equip)				CORA estimate	208300
2. Equipment Costs	Dedicated sampling pumps (purchased)	6	PUMP	$1,400.00		$8,400
	Total Direct Costs (TDC)					$1,494,971
INDIRECT CAPITAL COSTS						
	1. Engineering and Design				10% of TDC	$149,497
	2. Contingency Allowance				20% of TCC	$416,321
	3. Other Inderect Costs: (legal fees, permits, etc.)				1% of TCC	$20,816
	Total Indirect Costs					$586,634
TOTAL CAPITAL COSTS (TCC)						$2,081,605

TABLE F.17. WORKSHEET FOR ANNUAL OPERATING COSTS OF ALTERNATIVE 9

ALTERNATIVE 9
Institutional Action
Surface Cap
In-situ Groundwater Treatment

OPERATION/MAINTENANCE	COST COMPONENT	QUANTITY	UNIT	UNIT COST	BASIS	COST ($)	FREQUENCY	YEAR	ANNUAL COST
O & M COST:									
1. Operating Labor									
Sampling	Purge and sample 15 wells quarterly								
Labor:	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, engineer	10	DAY	$93.00		$930	4	1-30	$3,720
	Geologist	80	HR	$57.86		$4,629	4	1-30	$18,515
	Perdiem, geologist	10	DAY	$93.00		$930	4	1-30	$3,720
	Car rental (one car, engineer and geologist)	10	DAY	$39.41		$394	4	1-30	$1,576
	Shipping	10	COOLER	$72.00		$720	4	1-30	$2,880
	Equipment/supplies		LS		10% of total sampling labor	$1,359	4	1-30	$5,436
	Total O & M cost								$54,363
2. MAINTENANCE									
Material & labor	Dedicated pumps, sampling		LS	$400.00	5% of pump cost	$400.00	1	1-30	$400
	Fencing		LS	$700.00	2% of fence cost	$700.00	1	1-30	$700
	Cap inspect/maint				CORA est.		1	1-30	$15,000
	Ditch Maintenance (incl labor/equip)	1	MOWING	$400.00		$400.00	2	1-30	$800
	Total Maintenance, Materials and Labor								$17,900
4. PURCHASED SERVICES	Lab analysis								
	VOC samples								
	field sample	15	SAMPLE	$131.00		$1,965	4	1-30	$7,860
	filed duplicate	2	SAMPLE	$131.00		$262	4	1-30	$1,048
	matrix spike (MS)	1	SAMPLE	$131.00		$131	4	1-30	$524
	MS duplicate	1	SAMPLE	$131.00		$131	4	1-30	$524
	trip blank	5	SAMPLE	$131.00		$655	4	1-30	$2,620
	ambient blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	sample bank blank	1	SAMPLE	$131.00		$131	4	1-30	$524
	Metals samples								
	field sample	15	SAMPLE	$410.00		$6,150	4	1-30	$24,600
	filed duplicate	2	SAMPLE	$410.00		$820	4	1-30	$3,280
	matrix spike (MS)	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	MS duplicate	1	SAMPLE	$410.00		$410	4	1-30	$1,640
	Radiological samples (incl tritium, uranium, plutonium, thorium, gamma, radium, strontium, and americium and americium)								
	field sample	15	SAMPLE	$1,378.00		$20,670	4	1-30	$82,680
	filed duplicate	2	SAMPLE	$1,378.00		$2,756	4	1-30	$11,024
	matrix spike (MS)	1	SAMPLE	$1,378.00		$1,378	4	1-30	$5,512
									$144,000
4. MAINTENANCE RESERVE AND CONTIGENCY COSTS					1% of Capital Cost	$20,816	1	1-30	$20,816
TOTAL ANNUAL OPERATING COSTS									$237,079

F2. REFERENCES

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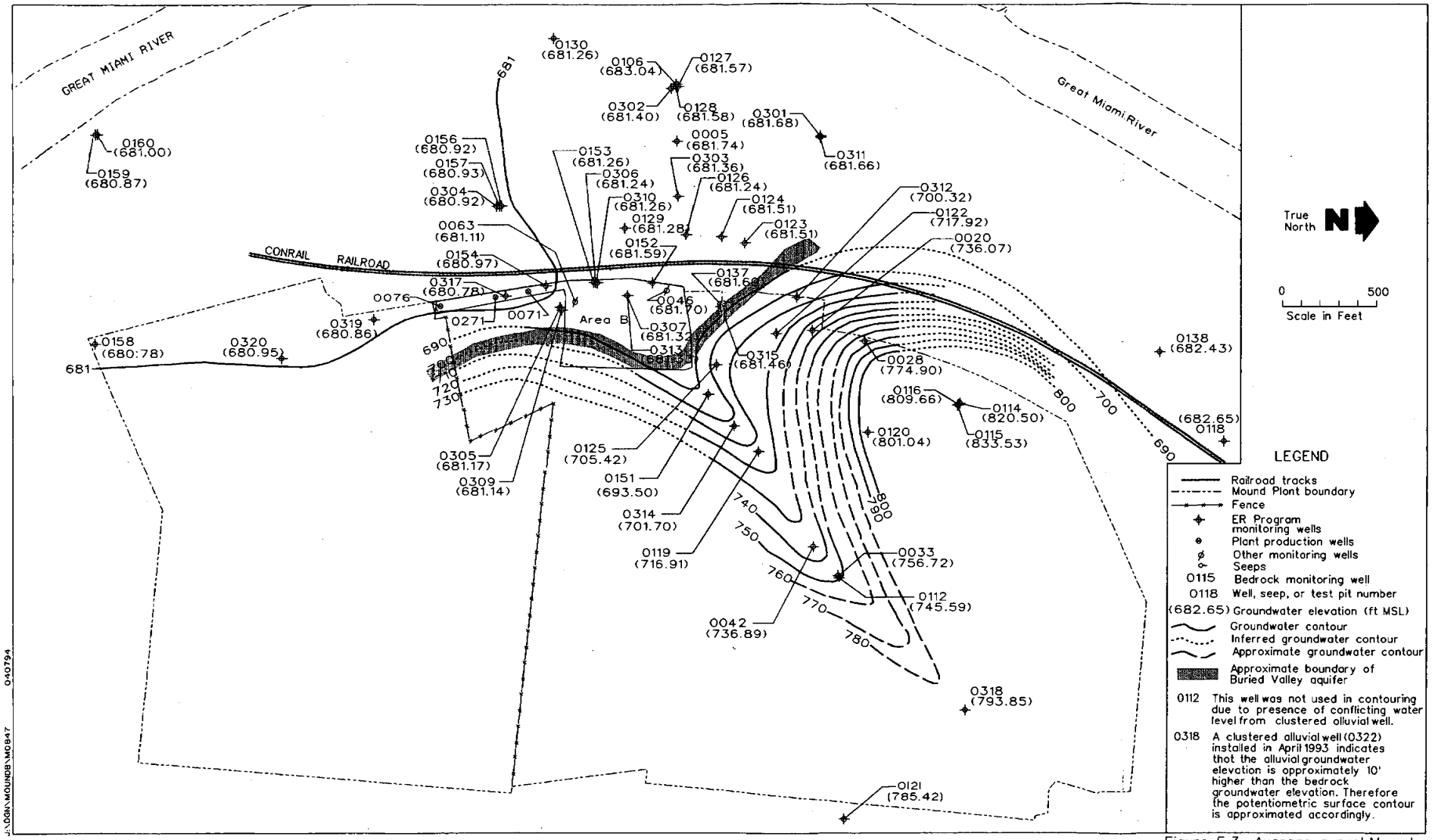

Figure E.3. Average annual Mound Plant groundwater elevation, June 1992 to March 1993.

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