AMENDED FEASIBILITY STUDY

Old Southington Landfill Superfund Site
Southington, Connecticut

Prepared for:

U.S. Environmental Protection Agency
Region I
Boston, Massachusetts

June 2006

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ABBREVIATIONS AND ACRONYMS

AFS	Amended Feasibility Study
ARARs	Applicable or Relevant and Appropriate Requirements
AS	air sparging
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COCs	constituents of concern
CT DEP	CT Department of Environmental Protection
DCE	dichloroethene
ELURs	Environmental Land Use Restrictions
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	Feasibility Study
GWTF	groundwater treatment facility
HRA	Health Risk Assessment
ICs	Institutional Controls
ISCO	in-situ chemical oxidation
LTMP	long-term monitoring program
MCLs	maximum contaminant levels
MPE	multi-phase extraction
MTBE	methyl tert-butyl ether
NCP	National Contingency Plan
NPL	National Priorities List
Order	Administrative Order on Consent
OSL	Old Southington Landfill
PAHs	polycylic aromatic hydrocarbons
PCBs	polycylic biphenyl compounds
PCE	tetrachloroethene
POTW	publicly-owned treatment works
PRBs	permeable reactive barriers
PRGs	preliminary remediation goals
PRPs	potentially responsible parties
PSDs	Performing Settling Defendants
Rd	retardation factors
RI	Remedial Investigation
ROD	Record of Decision
RSRs	Remediation Standards Regulations
SGI	Supplemental Groundwater Investigations
SOW	Statement of Work
SRI	Supplemental Remedial Investigation
SSDA	semi-solid disposal area
SVE	soil vapor extraction
SVOCs	semivolatile organic compounds
SWPC	Surface Water Protection Criteria
TCA	trichloroethane
TCE	trichloroethene
VC	vinyl chloride
VOCs	volatile organic compounds

1.0 INTRODUCTION

1.1 Purpose

This document provides the Amended Feasibility Study (AFS) for impacted groundwater at the Old Southington Landfill (OSL) Superfund Site. The work described in this report was completed pursuant to the June 1998 Consent Decree for the Site, as described in Attachment A to the Statement of Work (SOW), as well as subsequent agreements between the Performing Settling Defendants (PSDs), United States Environmental Protection Agency, Region I (EPA), and CT Department of Environmental Protection (CT DEP).

1.2 Organization of the Report

The AFS document is presented in six sections, each meant to build on the previous sections. The remainder of Section 1 provides an explanation of the Feasibility Study (FS) process; background information including history and a brief description of the Site, a summary of the conceptual model for the Study Area which is detailed in the Remedial Investigation (RI); a summary of the findings of the Human Health and Ecological Risk Assessments; and the development of remedial response objectives. The remaining sections of the AFS are as follows:

- Section 2 - Identification and Preliminary Screening of Remedial Technologies and Process Options
- Section 3 - Development and Initial Screening of Remedial Alternatives
- Section 4 - Detailed Evaluation of Remedial Alternatives
- Section 5 - Comparative Analysis
- Section 6 - References

1.3 Feasibility Study Process

The FS process provides for the development and evaluation of potential remedial alternatives that may be applicable for remediation of a given site. This Amended Feasibility Study evaluation is based upon the Remedial Investigation/Feasibility Study (RI/FS; ESE, 1993), the Baseline Health Risk Assessment (HRA; ESE, 1993), the Ecological Risk Assessment (ERA; ESE, 1993), and the Supplemental Remedial Investigation (MACTEC, 2005). The RI evaluates the nature and extent of the problem at a specific location, and the HRA and ERA provide the basis upon which the need for remedial measures is assessed and remediation goals are developed. The results of the FS detailed evaluation, along with risk-management judgments, will form the basis for selection by EPA of a preferred alternative and preparation by EPA of a proposed plan for the Site.

The FS process involves several development and evaluation steps for alternatives. First, response areas are identified and remedial response objectives are developed. Then, general response measures that have the potential to meet the response objectives are identified. For each general response measure, remediation technologies and processes specific to these technologies are then identified (Section 2). A preliminary screening of these technologies and specific processes is conducted to determine their applicability and technical feasibility. Those remedial technologies considered ineffective or unsuitable for implementation are eliminated from further consideration during the preliminary technology screening. In addition, technologies that have not been fully demonstrated and do not appear promising, or whose use would be precluded by location characteristics, are also eliminated from further consideration. Technologies/process options remaining after this screening step are evaluated with respect to their effectiveness, implementability, and relative costs. Based on this evaluation, representative process options are selected.

The representative technologies/process options that remain after the preliminary screening are combined and developed into potential remedial alternatives (Section 3). Acceptable engineering practice as well as applicable environmental standards are considered, as appropriate, in the development of the remedial alternatives. An initial screening evaluation, which consists of an evaluation of each alternative's effectiveness, implementability, and cost is conducted on each of the potential remedial alternatives. Those alternatives that do not protect public health or the environment or do not meet applicable or relevant and appropriate requirements (ARARS) are eliminated from further consideration. In addition, a cost comparison between like alternatives that provide a commensurate level of protection to public health and the environment is conducted.

A detailed evaluation, based on seven of the nine criteria enumerated in the National Contingency Plan (NCP), is conducted on the remedial alternatives remaining after this screening step (Section 4). The detailed evaluation includes an assessment of each alternative as it relates to the following criteria:

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

EPA will evaluate two additional criteria, state acceptance and community acceptance, following the public comment period on the proposed plan.

These nine criteria are categorized into three groups as follows:

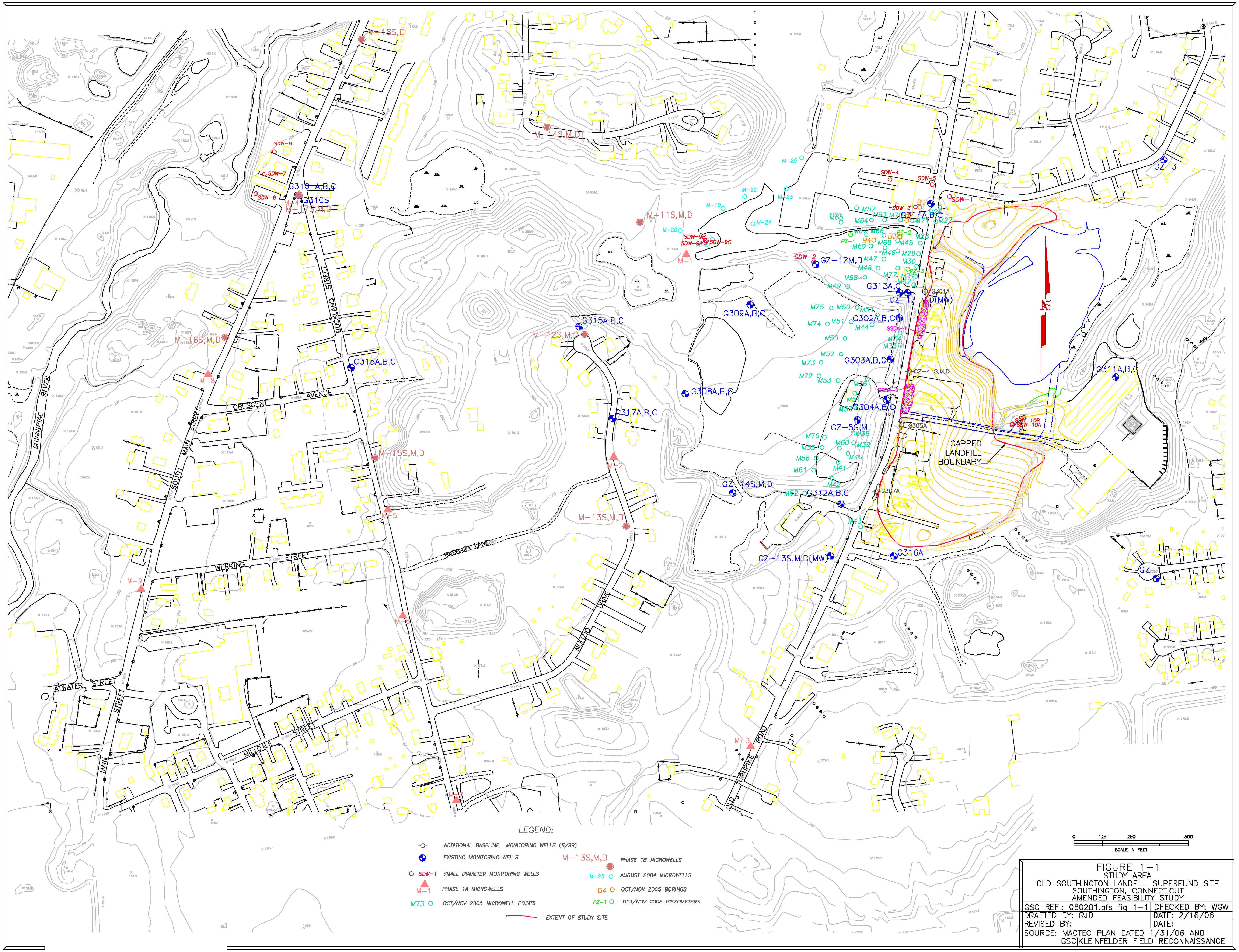
1. Threshold criteria, which include overall protection of human health and the environment, and compliance with ARARs. Unless a specific ARAR is waived, each alternative must meet these criteria in order to be eligible for selection.
2. Primary balancing criteria, which include long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost.
3. Modifying criteria, which include state and community acceptance. These modifying criteria are evaluated following the selection of a preferred remedy and preparation of a Proposed Plan.

Comparison of each alternative based upon the nine criteria described in the NCP provides the basis from which a remedial action plan is developed.

1.4 Background

The Old Southington Landfill Superfund Site (the Site) encompasses approximately thirteen acres on the east side of Old Turnpike Road in Southington, Connecticut (see Figure 1-1). The site is located approximately 3,100 feet to the east of the Quinnipiac River. Black Pond abuts the Site.

During the period from about 1920 to 1967, local residents and area businesses used portions of the landfill for disposal of waste materials. During this time frame, the landfill was known as the Old Turnpike Landfill. Based upon historical evidence, RI data, and difference in ownership between the northern and southern portion of the Site, the northern and southern portions of the landfill were used for distinct and separate purposes. The northern portion of the landfill was a "stump dump" that was used for the disposal of wood and construction debris. The southern portion of the landfill was used throughout the period the landfill was in



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operation for the co-disposal of municipal and industrial waste. Historical information, interviews with current and past Town employees, and information contained in public documents on disposal practices indicate that for a short period of time (1964-1967) two areas (SSDA 1 and SSDA 2) in the southern portion of the landfill (see Figure 1-1) were used for disposal of semi-solid industrial wastes. Closure of the landfill was completed shortly after it ceased operating in 1967 and included compaction, cover with two ft of clean fill, and seeding for erosion control. Between 1973 and 1980, the landfill property was subdivided and sold for residential and commercial development. Several residential and commercial buildings were built on the Site and on adjacent areas.

The landfill is located approximately 700 ft southeast of the former municipal Well No. 5, which was installed in 1965 by the Town of Southington Water Department and used as a public water supply. The Connecticut Department of Public Health and Addiction Services (then the Department of Health Services) sampled Southington Production Well No. 5, located west and north of the Site, on several occasions between December 1978 and March 1979. Analyses of the water samples collected indicated the presence of chlorinated volatile organic compounds (VOCs). Because of the detection of 1,1,1-trichloroethane (TCA) at levels that exceeded State standards, Well No. 5 was closed in August 1979. The well has permanently been closed since that time.

In February 1980, EPA authorized a hydrogeologic investigation aimed at defining the nature and extent of contamination in groundwater in the area around Well No. 5. Analysis of groundwater samples collected from two monitoring wells installed between the landfill and Well No. 5 indicated the presence of VOCs (Warzyn Engineering, Inc., 1980). In November 1980, the Connecticut Department of Environmental Protection (CT DEP) collected soil samples from a manhole excavation within the industrial park located on land that had previously been part of the landfill. Analysis of the soil samples indicated the presence of chlorinated and non-chlorinated VOCs.

Based on the above findings and a hazard ranking performed in 1982, EPA, on September 8, 1983, proposed that the Old Turnpike Landfill be placed on the National Priorities List (NPL), pursuant to Section 105(8)(b) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9605(8)(b). On September 21, 1984, the Old Turnpike Landfill was listed on the NPL as the Old Southington Landfill Superfund Site. On September 29, 1987, potentially responsible parties (PRPs) voluntarily entered into an Administrative Order on Consent (Order) with EPA. The Order sets out the requirements for the preparation and performance of a Remedial Investigation and Feasibility Study (RI/FS). Work plans were submitted and approved by EPA, as required, for each phase of the RI/FS. Because of the need to move quickly to address the landfill proper and the businesses and residences located on top of the landfill, a decision was made to issue an interim Record of Decision (ROD) rather than addressing the Site as a whole.

The Interim ROD was issued in September 1994. The Interim ROD required relocation of residences and businesses, relocation of SSDA1 materials into a lined cell beneath the cap, placement of a cap on the landfill, and continued groundwater investigations (Supplemental Groundwater Investigations or SGI). Construction of an impermeable synthetic cap over the landfill was completed in the fall of 2001.

This Amended Feasibility Study addresses the remaining portions of the Site that were not fully addressed in the Interim ROD. This AFS focuses on groundwater contamination beyond the edge of the landfill. Although surface water and sediment were also investigated further in the Supplemental RI, EPA believes there is no unacceptable risk at these portions of the Site. As a result, this AFS does not evaluate alternatives to address surface water or sediment.

1.5 Previous Investigations/Remedial Activities

The RI/FS Report was finalized on December 10, 1993, and included: (1) the RI; (2) a human health risk assessment; and (3) an ecological risk assessment and feasibility study. This report presented the findings based on data obtained over a six-year period.

1.5.1 Remedial Investigation/Feasibility Study

This section briefly summarizes the results of the RI/FS investigations.

1.5.1.1 Remedial Investigation

Overall, the RI results indicated that industrially related chemical waste was primarily deposited in the southern portion of the landfill. Volatile organic compounds (VOCs) were detected at sporadically high concentrations in soils throughout this portion of the landfill. Moderate concentrations of semivolatile organic compounds (SVOCs) [primarily polycylic aromatic hydrocarbons (PAHs)], polycylic biphenyl compounds (PCBs) and some metals were also detected, although less frequently. RI results identified two areas (SSDA 1 and SSDA 2) where semisolid industrial waste materials contaminated with relatively high levels of VOCs and/or SVOCs were deposited. Results also indicated that the northern portion of the landfill was basically used as a dump for stump and demolition debris with waste materials including wood, ash, cinders, and some brick and asphalt. Moderate concentrations of PAHs were detected at certain locations in the northern portion of the landfill.

RI/FS air quality evaluations for the landfill did not identify any unacceptable risks to human health from toxic air pollutant emissions. Similarly, although somewhat elevated levels of PAHs and a few metals were detected at certain sediment locations in Black Pond, risk assessment evaluations did not identify any unacceptable human health or environmental risks.

In addition, considerable work was conducted to evaluate the nature and extent of groundwater contamination. The results of that portion of the investigation are as follows:

- *Hydrogeology Within the Study Area*—The unconsolidated deposits form an unconfined aquifer. In the southern portion of the Site, large vertical hydraulic gradients (which are approximately ten times greater than the horizontal gradient) are associated with neighboring wetlands and ponding of surface water runoff in local depressions during rainfall events, significant groundwater recharge from Black Pond, and low-permeability waste debris in the landfill. These factors promote vertical drainage into the more permeable aquifer soils. Horizontal groundwater flow is generally east to west in the Study Area.
- *Nature and Distribution of Contaminants in Groundwater*—VOCs are the primary contaminants of concern (COCs) measured in groundwater and metals to a much lesser extent. SVOC, pesticides and PCB were rarely detected and when detected were at levels slightly above the detection limit during the RI. No VOCs were detected in groundwater downgradient from the northern portion of the landfill, which is consistent with the types of materials deposited there. [Note – as indicated in Section 1.5.2, recent (Fall 2005) field investigations have detected VOCs in shallow groundwater immediately downgradient of the northern portion of the landfill.] The north-south dimension of the contaminant plume downgradient of the southern portion of the Site indicates that contaminants introduced into groundwater are not from any single, isolated source area. The primary VOCs are chlorinated ethenes and petroleum related VOCs (benzene, toluene, and xylenes often termed BTEX), while other VOCs are infrequently detected at low levels. Metals were detected in excess of maximum contaminant levels (MCLs) in both background and downgradient wells during the RI.

1.5.1.2 Groundwater Receptors Study

As part of the RI, a groundwater receptors study was conducted between the landfill and the Quinnipiac River to determine whether any properties were not connected to the Town water supply. Old Turnpike Road, beginning at the intersection with Carter Lane and extending south to the intersection with Mulberry Street, bounds the survey area on the east. The southern boundary extended west on Mulberry Street (but included a portion of Mulberry Street east of Old Turnpike Road) to South Main Street. The western boundary paralleled the Quinnipiac River north on South Main Street to the intersection of West Main Street and Main Street. The northern survey boundary extended east on Main Street to the intersection with Maple Street. With one exception, all developed properties were on Town water supply. One home, located at 117 Crescent Avenue, was serviced by a private drinking water well installed in 1957, prior to Town regulations requiring connection to Town water. The home was subsequently connected to Town water and the private well was taken out of service (ESE, 1993).

1.5.1.3 Feasibility Study/Record of Decision for the Interim Remedy

Based upon the conclusions in the RI and the results of the human health and ecological risk assessments, the FS identified a number of options to address the landfill and groundwater contamination, although several questions remained regarding the groundwater. As discussed previously, a decision was made to move forward with an Interim ROD to address the landfill. The Interim ROD required placement of a cap on the landfill and the relocation of residents and businesses.

1.5.2 Supplemental Remedial Investigation

In addition to requiring the relocation of businesses and residents and capping the landfill, the Interim ROD recognized that additional groundwater, surface water and sediment investigations needed to be conducted before a final decision could be made addressing these portions of the Site. It was based upon this need for additional information that the Supplemental Groundwater Investigation and Amended Feasibility Study (SGI/AFS) was conducted. This SGI/AFS required:

- Additional groundwater investigations downgradient of the landfill;
- Placement of bedrock wells on-site; and
- Collection of data sufficient to complete an AFS and amended risk assessments, as needed.

Pursuant to a Consent Decree entered into for the Site in 1998, a group of Potentially Responsible Parties agreed to conduct the SGI/AFS. This Supplemental RI and AFS are the result of this agreement.

The Supplemental Remedial Investigation Report (SRI; MACTEC, 2005) provided a compilation of the Supplemental Groundwater Investigations (SGI) results completed since the original RI/FS (ESE, 1993). The SGI began in spring 1999 and included the following investigative activities:

- Seventy-seven (77) new groundwater sampling points installed at 45 locations;
- Two (2) Study Area-wide hydraulic surveys;
- More than 550 groundwater samples were collected for laboratory analyses;
- Two (2) additional groundwater receptor studies;
- Three (3) additional Black Pond surface water and sediment sampling events; and
- Fourteen (14) groundwater-sampling events.

A brief summary of the findings of the SRI follows.

1.5.2.1 Groundwater Flow

The SGI confirmed the groundwater flow pathways described in the RI and extended the delineation of groundwater flow west to the Quinnipiac River Basin.

General groundwater flow follows the bedrock topography, flowing along a west-northwest trending bedrock trough; the impact of the bedrock topography is greatest on the groundwater flow in the deeper portions of the aquifer.

The bedrock surface rises in the western part of the Study Area, pinching out the overburden groundwater aquifer west of the Quinnipiac River.

1.5.2.2 Plume Delineation

- As detailed in the RI and confirmed in the SRI, contaminants from the waste mass in the Southern Portion of the Site almost immediately flow down into the medium to deep portions of the aquifer, below the landfill, due to significant differences in the permeability of the waste mass versus the very permeable sand and gravel aquifer, and are then transported at depth west by regional groundwater flow;
- Contaminants in shallow groundwater immediately west of the Site (e.g., at G304A and G302A) also migrate into the lower portion of the aquifer; this is likely due to the large groundwater recharge areas west of Old Turnpike Road overlying the full north-south extent of the contaminant plume;
- Vertical hydraulic gradients west of the Site are generally flat with some minor upward and downward variation depending upon location; therefore, the contaminant plume remains in the middle or deep portion of the aquifer as it moves west/northwest;
- The groundwater contaminant plume is generally bounded on the north by well SDW9C and south by well GZ14D (although some uncertainty exists regarding the southern boundary); the north-south boundaries of the plume are consistent with the position of the bedrock trough, the impact of which on the plume is significant because the plume is located in the deeper portion of the aquifer;
- The groundwater contaminant plume intersects the Quinnipiac River Basin in the vicinity of well G310 and the groundwater plume has been delineated to its western most downgradient point prior to the Quinnipiac River (G310S, A, B, and C; SDW-6; SDW-7, and SDW-8); and
- Bedrock topography west of the Quinnipiac River ensures that groundwater cannot move significantly west of the River but must remain in the Quinnipiac River Basin, ultimately moving south with regional basin flow and/or discharging to the Quinnipiac River.

1.5.2.3 Constituents of Concern in the Plume

- The primary constituents of concern (COC) in the contaminant plume are trichloroethene (TCE) and its related daughter products (1, 2-dichlorethene (1,2-DCE) and vinyl chloride); other VOCs, including several aromatic BTEX compounds, when detected, are within the footprint of the TCE plume and are generally measured at concentrations considerably lower than TCE-related;
- No semi-volatile organic compounds (SVOCs) plume is emanating from the Site. SVOCs have only been detected sporadically throughout the Study Area at trace concentrations;
- No metals plume is emanating from the Site; metals have been detected sporadically downgradient of the Site;

- Methyl tert-butyl ether (MTBE) has been measured sporadically at high concentrations at wells within the footprint of Chuck & Eddies (an auto salvage yard) west of the Site; the detections of MTBE are not believed to be related to the Site;
- In 2000 a slug of TCE-related VOC was detected at G302A; this slug has subsequently been tracked in the lower portions of the aquifer to GZ12M and to SDW-9C, and is following a flowpath consistent with the northern boundary of the bedrock trough, as it flows to its likely discharge in the Quinnipiac River Basin; and
- Analytical results for surface water and sediment samples collected during the SGI were similar in concentrations to the data collected during the RI and used for the ecological and human health risk assessments; the data collected during the SGI for surface water and sediment confirm the findings of the RI risk assessments that these media do not present an unacceptable human health or ecological risk.

1.5.2.4 Comparison to Regulatory Criteria

- Groundwater within the Study Area and the area between the Site and the Quinnipiac River is assigned a "GB" classification under the Connecticut Department of Environmental Protection's (CT DEP) Water Quality Standards; under Connecticut law this means that the groundwater is not suitable for drinking water.
- As a result, state and federal drinking water requirements are not required to be met. Thus, the primary ARARs will be the volatilization criteria of the CT DEP Remediation Standards Regulations (RSRs).
- Groundwater does not discharge to a surface water except at the Quinnipiac River; COC concentrations close to the point of discharge to the Quinnipiac River do not exceed the SWPC.
- Exceedances of the RSR volatilization criteria for residential or commercial land use have occurred at six wells, G302A, G303A, G304A, G314A, SDW-3 and SDW4, during recent quarters (December 2003 - September 2005); all of these wells are located on commercial property and, using the proposed volatilization criteria, only G304A exceeds an industrial/commercial volatilization criteria (cis-1, 1-dichloroethene, trichloroethene, and vinyl chloride). Residential RSR values (current and proposed) were not exceeded in areas which currently support residential land use and which were sampled. However, it should be noted that additional exceedances of RSR commercial and/or residential volatilization criteria were observed during the fall 2005 drive point groundwater sampling investigation at a number of commercial property locations downgradient of the south-central and north-central portions of the landfill.
- The groundwater receptors studies conducted during the RI and the SGI have determined that drinking water is supplied to all properties within the GB area and that groundwater within the GB area is not used for drinking water.

1.6 Groundwater Classification

Figure 1-2 shows the current groundwater classification boundaries in the Study Area. The Study Area is classified as GB. Designated uses for Class GB groundwater include: (1) industrial process water and cooling waters; and (2) base-flow for hydraulically connected surface water bodies presumed not suitable for human consumption without treatment.

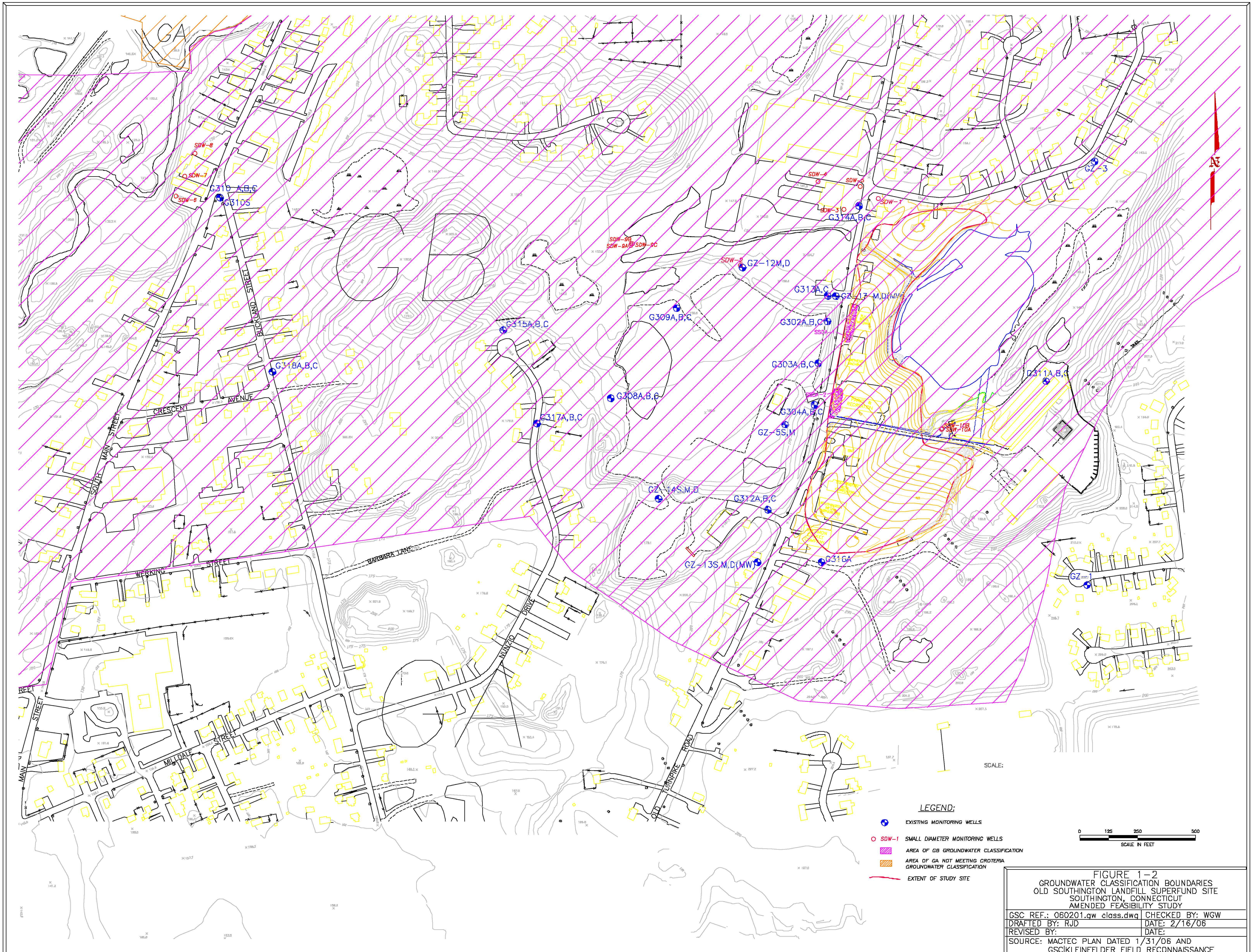


FIGURE 1-2
GROUNDWATER CLASSIFICATION BOUNDARIES
OLD SOUTHINGTON LANDFILL SUPERFUND SITE
SOUTHINGTON, CONNECTICUT
AMENDED FEASIBILITY STUDY

GSC REF.: 060201.gw class.dwg	CHECKED BY: WGW
DRAFTED BY: RJD	DATE: 2/16/06
REVISED BY:	DATE:

SOURCE: MACTEC PLAN DATED 1/31/06 AND GSC|KLEINFELDER FIELD RECONNAISSANCE

1.7 Conceptual Model for the Study Area

1.7.1 Introduction

The investigations conducted during the SGI have developed data that are consistent with and expand upon the RI conceptual model. This section provides a refined conceptual model based on the data collected during the SGI.

As demonstrated in the first RI/FS, the source of the large majority of the groundwater plume is the waste mass in the Southern Portion of the Site and that waste mass is both above, and to a lesser extent, below the water table. Groundwater containing COCs was identified emanating from the Southern Portion of the landfill. The primary COCs in the contaminant plume are TCE and its related daughter products (1,2-DCE and vinyl chloride); other VOCs, when detected, are within the footprint of the TCE plume and are generally measured at concentrations considerably lower than TCE-related VOCs. However, elevated concentrations of aromatic BTEX compounds are observed at shallow well G304A. No SVOC plume is emanating from the Site and SVOC have only been detected sporadically throughout the groundwater at trace concentrations. Likewise, no metals plume is emanating from the Site and metals that have been detected have been detected only sporadically, downgradient of the Site.

The plume has been effectively delineated using VOCs as the indicator contaminants. VOCs are the most mobile in terms of fate and transport, and, therefore, provide the best indicator of contaminant migration in groundwater leaving the Site.

Based on extensive hydraulic investigations, the SGI results indicate that most of the VOCs migrating out of the landfill move with groundwater west/northwestward from the Site in a relatively narrow plume, ultimately discharging to the Quinnipiac River. As noted above, the major fraction of the VOC plume originates in the southern portion of the landfill. Due to strong downward vertical hydraulic gradients, the plume leaving this portion of the landfill moves to the lower portion of the aquifer as it leaves the site. It remains in the lower portion of the aquifer to the west of Chuck & Eddie's junkyard at monitoring locations G308 and G309.

Also, the first RI/FS verified that there are no groundwater receptors downgradient of the Site because the entire area potentially impacted by the VOC plume is serviced by public water supply and private drinking water wells are prohibited. The RI/FS concluded, as supported by the RI conceptual model, that there are no groundwater receptors downgradient of the Site that could be impacted by the plume.

As the SRI demonstrates, Site-related COCs in groundwater downgradient of the Site do not adversely impact environmental media other than groundwater. The large majority of the COCs are transported by groundwater as a relatively narrow plume into the lower portion of the aquifer immediately downgradient of the Site and remain in the lower portion of the aquifer, with ultimate discharge into the Quinnipiac River Basin west-northwest of the Site. This refined conceptual model also demonstrates that non-VOC COC from the Site do not exist in downgradient groundwater at concentrations greater than applicable regulatory criteria.

1.7.2 Groundwater Flow

The RI and SRI data are consistent with the Site geology and demonstrate a strong downward flow component near the Southern Portions of the Site. This downward flow is the result of the significant difference in permeability between the low permeability of the waste mass and the high permeability of the sand and gravel aquifer and depression through precipitation recharge. Groundwater from the Southern Portion of the Site enters the lower part of the aquifer quickly and remains in the lower aquifer until it is influenced by the Quinnipiac River Basin and rising bedrock surface. In the Northern Portions of the Site, vertical hydraulic gradient is less pronounced and the VOC plume travels downward more slowly.

Contaminants that were released from shallow sources remain shallow immediately west of the Site as demonstrated by the analytical data at G304A. However, these contaminants also migrate downward into the lower portions of the aquifer as they move west. This is demonstrated by the absence of contaminants in the shallow groundwater at all locations downgradient of G304A (G308A, G309A, G315A). The downward migration of contaminants across this area between G304 and G308/G309 is accounted for by the large groundwater recharge this area provides to the shallow aquifer.

Groundwater generally flows from the Site to the vicinity of wells B308/309 in an east to west direction, and gradually shifts to an approximate northwesterly direction as the hydraulic influence of the Quinnipiac River Basin becomes more pronounced. Plan-view maps of the water level contours near the Quinnipiac River indicate that groundwater is discharging into the river basin rather than flowing beneath it. This interpretation takes into account the fact that the boundary of the aquifer is located about 800 ft northwest from the river, thus prohibiting flow beneath the river basin to the northwest. Groundwater from the Site and from the west side of the river converges and discharges into the Quinnipiac River Basin.

1.7.3 Contaminant Transport in Groundwater

In general, contaminant migration and distribution between air, water, sediment, and soil depend on both hydrogeologic and compound-specific parameters. Hydrogeologic factors such as hydraulic conductivity, hydraulic gradient, and porosity determine groundwater velocities and directions in the aquifer. Dissolved constituents move with the groundwater, but the migration rates may be retarded (i.e., less than the groundwater velocity) due to interaction of the contaminants with the soil particles within the aquifer. The extent of contaminant retardation is a function of several variables, including the physical-chemical character of the contaminant and the soil. All dissolved constituents will follow the groundwater flow path.

VOCs, and most significantly TCE-related VOCs, are the primary constituents of concern in groundwater. Although other VOCs have been detected in groundwater, their presence is sporadic and concentrations are significantly less than for TCE-related VOCs. No SVOC or metals plumes have been found to be emanating from the Site. No elevated SVOC detections have been seen downgradient of the Site. The metals that have been detected are sporadic in nature, as are the concentrations. There is no pattern of metals concentrations that define a plume emanating from the landfill.

1.7.3.1 Transport of Organic Compounds

<u>VOC Transport</u>

VOC concentrations in groundwater are elevated in the shallow part of the aquifer beneath and near the Site. West of the Site, the VOC plume generally migrates into the deeper portions of the aquifer, and VOC concentrations increase with depth. This is consistent with the observed hydrogeology, causing a strong downward gradient beneath the Southern Portion of the Site. This portion of the landfill is the main source of contaminants to groundwater. The VOC concentrations decrease with distance from the Site due to biodegradation, rainwater dilution, and dispersion. The cap on the Site has had little impact on groundwater hydraulics.

Bedrock topography beneath the Site has a significant impact on deep groundwater flow. The presence of a bedrock trough running towards the west-northwest is consistent with the groundwater hydrogeological data. This bedrock trough accounts for the distribution of contaminants and plume delineation.

The contaminants that migrate into the lower portion of the aquifer near the Site remain in the lower aquifer until influenced by the Quinnipiac River Basin, where the VOC plume moves upward and discharges into the river basin.

SVOC Transport

Based on data collected during the RI, as confirmed by the SRI, SVOC migration downgradient of the Site has not occurred. Fourteen monitoring wells have been sampled and analyzed for SVOCs starting in December 2003. Generally, SVOCs have not been detected in groundwater downgradient of the Site. When detected, SVOCs are at trace levels, primarily phthalates. The data confirm the absence of an SVOC plume emanating from the Site.

Many SVOCs typically have a high affinity for soils (i.e., very high soil-water partition coefficients) that limits their transport in groundwater. The lack of SVOCs in groundwater downgradient of the Site, despite the occurrence of limited SVOCs in soil within the Site, is consistent with these general SVOC transport characteristics.

1.7.3.2 Metals Transport

The analytical data collected during the RI, and confirmed in the SRI, demonstrates the lack of a metals plume emanating from the Site. This is predictable based on what is known about disposal practices at the Site and about the fate and transport of metals species in the environment There is no evidence of large volumes of liquid metals bearing wastes being disposed of in the landfill.

Most metals that are solubilized into the groundwater will in general, bind easily to soils in the aquifer and have a much greater affinity to the soils than to groundwater. Metals that are released into groundwater will be released very slowly and, therefore, will result in only low concentrations of metals in groundwater. Once in the groundwater, metals will migrate with groundwater at a very slow rate due to high retardation factors. This results in significantly long transport time periods.

Based upon calculations included in the SRI, the metals detected exhibit very low mobility with characteristic retardation factors (Rd) ranging from 100 to 100,000; approximately 100 times slower than TCE (Rd = 2 to 3), the least mobile VOC detected in the downgradient plume. For example, the estimated 60-year travel distance for copper, lead, barium, manganese, and chromium (III) is less than 150 ft. Therefore, the extent of metals migration beyond the Site boundary is expected to be very limited, as confirmed by the data. As stated above, this results in a single COC plume emanating from the landfill, consisting of VOC.

1.7.4 Surface Water and Sediment

Based on discussions with EPA and CT DEP, surface water and sediment samples have been collected three times during the SGI. Surface water and sediment samples were collected around Black Pond and within the unnamed stream on two occasions during the RI. VOC samples were collected for two consecutive years following the placement of the cap, at two locations within Black Pond. These data demonstrate that the placement of the cap did not impact the surface water or sediment.

The ecological and human health risk assessments conducted during the RI/FS (ESE, 1993) concluded that there was no unacceptable risk to human health or the environment related to surface water or sediment. At the request of EPA, surface water and sediment samples were collected for VOCs, SVOCs, and metals from three locations around Black Pond to confirm that the levels of contaminants are similar in concentration to those considered during the risk assessments.

As discussed in Section 4.2 of the SRI, contaminant levels detected in surface water and sediment samples collected during the SGI are lower than or similar to the contaminant levels used in the risk assessments, confirming that there is no risk to ecological and human health, as determined in the RI risk assessments.

1.7.5 Groundwater Discharge to Surface Water

1.7.5.1 Black Pond

As discussed in Section 3.3.3.1 of the SRI, hydraulic studies around Black Pond indicate that groundwater from beneath the landfill does not appear to discharge to Black Pond, due to the Pond's elevation being higher than the surrounding water table. In addition, with the cap in place, surface runoff to Black Pond is not in contact with wastes or contaminants within the landfill.

1.7.5.2 Unnamed Stream and Wetlands

As discussed in Section 3.3.3.2 of the SRI, hydraulic studies along the Unnamed Stream also indicate that groundwater does not discharge to the unnamed stream or wetlands. Furthermore, shallow groundwater beneath and in the area of the Unnamed Stream does not contain contaminants at concentrations that could adversely impact the stream.

1.7.5.3 Quinnipiac River

The contaminant plume from the Study Area is at a relatively low concentration in the deeper wells at G310 (in September 2004, TCE equivalents were 0 ppb at G310S, 68 ppb at G310A, 232 ppb at G310B, and 13 ppb at G310C). [Note: The TCE-equivalent concentration [$(TCE)_{equivalent}$], represents the molar sum of the concentrations for TCE and its biotransformation daughter products DCE and vinyl chloride (VC)]. Likewise, no VOCs have been detected in the three shallow wells installed between G310 and the river (e.g., SDW-6, -7, and -8), indicating that the plume remains in the deeper portion of the aquifer until it merges with the easterly and southerly flowing groundwater in the Quinnipiac River Basin. The concentrations in the aquifer will be further reduced by dilution as the contaminant plume mixes with the River Basin aquifer prior to discharging to the Quinnipiac River.

The impact of groundwater contaminants to the Quinnipiac River will be minor because the concentrations in the groundwater are low and considerable additional dilution and mixing will occur in the Quinnipiac River Basin. This is further corroborated by the fact that a comparison of the groundwater quality data from the G310 wells to the Connecticut SWPC demonstrate that the maximum concentrations of constituents within the VOC plume that have ever been detected in any of the four G310 wells, as well as at SDW-6, -7, and -8, are generally at least an order of magnitude below the applicable SWPC.

The River is classified as C/B, indicating a degraded condition upgradient as well as downgradient of the Study Area. The Quinnipiac River basin has numerous upstream VOC sources. The complexity of the system is such that definition of the OSL plume would become hard to detect once it mixes with the groundwater in the Quinnipiac River Basin aquifer.

1.8 Amended Human Health Risk Assessment

1.8.1 Summary of the Existing Human Health Risk Assessment

A human health risk assessment (HRA) was performed as part of the RI to determine the level of human health risk posed by the Site and is included as Volumes 2A and 2B of the RI/FS (ESE, 1993). The risk evaluation assumed that capping of the Study Site would be the presumptive remedy. The results of this risk assessment indicated that there were no significant potential health threats to: (1) on-site workers (either indoor or outdoor); and (2) to potential waders or swimmers. Elevated cancer risks have been calculated for the on-site resident, due mainly to exposures to potentially carcinogenic PAH in surface soil in its present condition. An analysis of the hypothetical future use of groundwater as drinking water indicated that potential health risks would be associated with this exposure pathway primarily because of chlorinated VOCs.

Estimated health risks associated with potential exposure pathways related to groundwater, surface water and sediments are summarized below:

Receptor/Exposure Pathway(s)	Non-Cancer Risks (EPA target value is Hazard Index <1)		Carcinogenic Risks (EPA target value is 1 in 1,000,000 to 1 in 10,000)	
	Average Case	Conservative Maximum Case	Average Case	Conservative Maximum Case
Swimmer in Black Pond exposed to surface water via incidental ingestion and dermal contact and sediment via dermal contact	0.04	0.16	2 in 1,000,000	5 in 1,000,000
On-site wader in wetland area exposed to surface water via dermal contact and sediment via dermal contact and incidental ingestion	0.034	0.11	4 in 100,000	1.1 in 10,000
Off-site wader in wetland area exposed to surface water via dermal contact and sediment via dermal contact and incidental ingestion	0.009	0.024	1 in 100,000	3 in 100,000
Future hypothetical off-site resident exposed via ingestion of groundwater used as drinking water	63	1420	3 in 1,000	1 in 10

1.8.2 Comparison of Current Data to the Existing Human Health Risk Assessment

The groundwater beneath the Study Area is classified by CT DEP as a GB area. Groundwater use for drinking is precluded by the Town in all areas of the Study Area. Groundwater receptor studies have been completed and confirmed that no wells are being used for drinking water. Therefore, the exposure pathway for ingestion of groundwater has been eliminated. The remaining potential exposure pathways are related to surface water and sediment.

Based on PSD discussions with EPA and CT DEP, surface water and sediment samples were collected during the SGI. The results are similar in concentration in the SGI samples as compared to the RI samples. These data support the findings of the RI HRA that these pathways do not present an unacceptable risk to human health.

Since the RI HRA was completed, a greater emphasis has been placed on the potential for volatilization of VOCs from groundwater as an exposure pathway to homes or commercial/industrial buildings. CT DEP has developed risk-based standards to address volatilization from groundwater. Those standards are an ARAR for this Site [see Table 1-1] and are considered in setting the remedial objectives and goals.

The SGI determined that no other media were impacted by the contaminated groundwater in the Study Area, as detailed in the Final Phase 2A Report (Harding ESE, 2001).

1.9 Amended Ecological Risk Assessment

1.9.1 Summary of Existing Ecological Risk Assessment

An ecological risk assessment (ERA) was also conducted during the RI and is included as Volumes 2A and 2B of the RI/FS (ESE, 1993). The ERA included the delineation of existing wetlands and an evaluation of the social significance, effectiveness, and viability of the wetlands, as well as an evaluation of potential impacts to aquatic and terrestrial wildlife. The ERA relied upon previous ecological field assessments and surface water and sediment analytical data collected during the RI and concluded that potential risks to aquatic or terrestrial wildlife are generally minimal, and limited to specific, isolated locations.

Table 1-1
Chemical Specific ARARs: Criteria, Advisories and Guidance
Old Southington Landfill Superfund Site
Southington, Connecticut

Medium	Requirements	Status	Synopsis of Requirement	Applicable Alternatives
Groundwater/ Vapor Intrusion	Federal EPA Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils	To Be Considered	Non-enforceable guidelines establishing pollutant concentrations which are considered to be adequate to protect indoor air quality.	GW1 GW2 GW3
Groundwater/ Vapor Intrusion	Connecticut Draft Characterization Guidance Document, dated June 12, 2000. Connecticut Draft 3/18/03 Proposed Revisions to Connecticut's Remediation Standard Regulations Volatilization Criteria, dated March 2003.	To Be Considered	Proposed standards for volatilization criteria	GW1 GW2 GW3
Groundwater/ Vapor Intrusion	Connecticut Remediation Standard Regulations (RCSA 22a-133k -3 (c))	Applicable	Establishes remediation standards for contaminated groundwater including standards for volatilization. Volatilization criteria address levels in groundwater that present a possible unacceptable risk where residential/commercial/industrial buildings are located above groundwater that exceeds these levels. Alternative GW1 does not meet this requirement. Alternatives GW2 and GW3 meet this requirement.	GW1 GW2 GW3

Table 1-1 (Continued)
Action Specific ARARs: Criteria, Advisories and Guidance
Old Southington Landfill Superfund Site
Southington, Connecticut

Medium	Requirements	Status	Synopsis of Requirement	Applicable Alternatives
Groundwater/ Vapor Intusion	CT Hazardous Waste Management: Generator & Handler Requirements – General Standards, Listing & Identification (RCSA 22a-449(c) 100-101)	Applicable	Establish standards for listing and identification of hazardous waste. The standards of 40 CFR 260-261 are incorporated by reference. Any waste material generated under this option that is determined to be hazardous shall be treated, stored and disposed of in accordance with these requirements.	GW2 GW3
Groundwater/ Vapor Intrusion	Environmental Land Use Restrictions (RCSA 22a-133q-1)	Applicable	Establishes requirements for placement of environmental land use restrictions.	GW2 GW3
Groundwater/ Vapor Intrusion	Connecticut Remediation Standard Regulations (RCSA 22a-133k -3 (c))	Applicable	Establishes remediation standards for contaminated groundwater including standards for volatilization. These regulations include options for addressing vapor intrusion. Alternative GW1 does not meet this requirement. Alternatives GW2 and GW3 meet this requirement.	GW1 GW2 GW3
Groundwater	Groundwater Monitoring 40 CFR 264 Subpart F	Relevant and Applicable	Standards for groundwater monitoring	GW2 GW3
Air	Connecticut Air Pollution Regulations – Fugitive Dust - RSCA 22a-174-18(b)	Applicable	Requires that reasonable precautions be taken to prevent particulate matter from become airborne during construction and material handling operations.	GW3
Groundwater	Connecticut Well Drilling Industry Regulations - RSCA 25-128-33 through 64	Applicable	Apply mainly to any new water supply or withdrawal wells. The rules specify that non-water supply wells must be constructed so that they are not a source or cause of groundwater contamination.	GW3
N/A	Federal – RCRA standards for hazardous waste generators – 40 CFR 262	Applicable	Generators of hazardous waste must obtain an EPA identification number, characterize waste streams, label and date containers, use a manifest and use an approved transporter.	GW2 GW3
N/A	Connecticut Guidelines for Soil Erosion and Sediment Control (May 2002)	To Be Considered	Provides technical and administrative guidance for the development, adoption and implementation of an erosion and sediment control program. May 2002 document also identified as DEP Bulletin 34.	GW3

The ERA resulted in the following findings related to this AFS:

- Surface water is not adversely impacted by chemical stressors identified at the Site and is not a significant risk to environmental receptors; and
- Metals identified at the Site do not adversely impact sediments. Sediments in sampling locations SED-5, SED-6, and SED-8 have been somewhat impacted by PAH and chlordane. However, it is unlikely that a risk exists to environmental receptors because of the lack of bioavailability of these compounds at the concentrations detected.

1.9.2 Comparison of Current Data to the Existing Ecological Risk Assessment

Based on discussions with EPA and CT DEP, surface water and sediment samples have been collected during the SGI. The results are similar in concentrations in the SGI samples as compared to the RI samples. These data support the findings of the RI ERA.

The SRI determined that no other media were impacted by the contaminated groundwater in the Study Area, as detailed in the Final Phase 2A Report (Harding ESE, 2001).

1.10 Development of Remedial Action Objectives

1.10.1 Identification of Remedial Action Objectives

The following specific remedial action objective applies to groundwater in the Study Area:

- Prevent inhalation of VOCs by occupants of residential/commercial/industrial buildings resulting from volatilization of VOCs in groundwater, in excess of 10^{-4} to 10^{-6} excess cancer risk, hazard index >1 or applicable, relevant, and appropriate volatilization criteria.

As a result, this AFS is limited to addressing contaminants in groundwater that present an unacceptable inhalation risk/exceeding volatilization criteria within the Study Area.

1.10.2 Identification of Preliminary Remediation Goals

For purposes of this AFS, the preliminary remediation goals (PRGs) are the identified volatilization criteria in the CT RSRs. VOCs are present in groundwater primarily in the middle to deep portions of the aquifer. VOCs are present in shallow groundwater in only relatively limited areas of the Site. Concentrations of VOCs in shallow groundwater in excess of the CT RSRs residential or commercial/industrial volatilization criteria are limited spatially, and are limited to trichloroethylene and vinyl chloride. Locations where CT RSR criteria are exceeded are identified in the SRI.

To supplement groundwater data for VOCs collected during the SGI, an extensive shallow groundwater VOC sampling and analysis effort was completed in the late fall 2005 on the properties immediately downgradient of the Site to carefully define the extent of areas where either criteria is exceeded. Based on that sampling and analysis effort, areas where residential or commercial/industrial volatilization criteria may be exceeded have been delineated.

2.0 IDENTIFICATION AND PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

2.1 Introduction

In this section, potential technologies and process options that may be applicable for remediation of the groundwater are preliminarily screened. This screening process supports the development of potential remedial alternatives. The preliminary screening process involves the following sequence of evaluations:

1. General response measures that have the potential to satisfy the remedial objectives identified in Section 1.10 are identified (Section 2.2).
2. Potential technologies and process options associated with each of the general response measures are identified (Section 2.3.1).
3. The identified technologies and process options are screened based on technical feasibility in the Study Area, and those that are not technically feasible are eliminated from further consideration (Section 2.3.2).
4. The retained technologies and process options are evaluated based on their potential effectiveness, implementability and relative costs. Based on this evaluation, a representative process option is selected for each retained technology type in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. The retained technology types and process options are then combined and then again reevaluated based upon effectiveness, implementability, and cost.

2.2 Identification of General Response Measures

The following summarizes general response measures that may be appropriate for the groundwater:

No Action – A no-action response provides a baseline assessment for comparison with other alternatives that contain greater levels of response. An alternative involving no action may be considered appropriate when the risk associated with a response area is within the acceptable range. An evaluation of the no-action response is required by the NCP as part of the FS process. In some cases, the no-action response may include some limited form of action, such as periodic sampling and analysis.

Management/Containment – Management/containment includes implementation and maintenance of controls designed to inhibit or limit access to a response area/media. These may include physical barriers, engineering controls, or institutional controls.

Active Remediation – Active remediation includes installation and maintenance of a treatment technology designed to reduce groundwater VOC levels preferably below appropriate CT RSR criteria. This treatment technology may be supplemented by physical barriers, engineering or institutional controls.

2.3 Identification and Screening of Potential Technologies/Process Options

As presented on Table 2-1 and summarized below fourteen (14) technology/process options are identified for groundwater. They are all considered potentially applicable. Following screening for effectiveness, implementability and cost, seven (7) of these technology/process options have been retained for use in development of remedial alternatives. These representative process options will be used in Section 3 to develop potential remedial alternatives for groundwater in the Study Area.

Table 2-1
Technology/Process Option, Description and Screening
Volatilization of VOCs from Groundwater

Response Measure/Technology	Process Option	Description	Screening Comments
No Action			
No Action	Not Applicable	• No additional measures would be employed.	Required for consideration by NCP.
Management			
Institutional Controls (ICs)	Environmental Land Use Restrictions (ELURs)	• Addition to property deed limiting future use. • Restrictions addressing exceedances of residential or commercial/industrial CT RSRs volatilization criteria in groundwater.	Potentially applicable.
Engineering Controls	Building Ventilation (Subslab Depressurization)	• Building ventilation controls acceptable to CT DEP, that either prevent migration of VOC vapors into, or control the level of VOCs in vapor beneath or in, any existing buildings located on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs volatilization criteria.	Potentially applicable.
	Vapor Barriers	• Engineered barrier installed beneath the foundation of buildings to prohibit migration of VOCs in soil gas beneath the building due to the presence of VOCs in groundwater exceeding the residential or commercial/industrial CT RSR volatilization criteria.	Potentially applicable.
Monitoring	Not Applicable	• Periodic monitoring of groundwater concentrations over time.	Potentially applicable.
Groundwater Treatment			
Containment	Horizontal Barriers	• Use of a cap or other horizontal barrier to prevent contact with VOC contaminated groundwater or vapor.	Potentially applicable.
	Vertical Barriers	• Use of vertical containment such as sheet piling, cut-off walls, or curtains.	Potentially applicable.
Extraction	Groundwater Pump-and-Treat	• Collection, treatment, and discharge of contaminated groundwater.	Potentially applicable.
	Air Sparging/ Soil Vapor Extraction (AS/SVE)	• Use of air injected into the saturated zone below or within the areas of groundwater contamination while simultaneously applying a vacuum to vapor extraction wells, to induce air flow through the contaminated vadose zone soil. • Volatilizes VOCs and provides some oxygenation leading to improved bioremediation.	Potentially applicable.
	Total Fluids Extraction	• Also known as multi-phase extraction (MPE). • A combination of groundwater extraction and SVE.	Potentially applicable.
In-Situ Treatment	Thermal Treatment	• Includes steam injection, six-phase heating, and radiofrequency heating of the subsurface, where increased temperatures help to volatilize VOCs and enhance in-situ oxidation. Vaporized contaminants are removed by an SVE network and then treated in a vapor treatment system.	Potentially applicable.
	Chemical Oxidation	• In-situ chemical oxidation (ISCO) involves the injection of a chemical oxidant such as hydrogen peroxide, potassium permanganate, sodium permanganate or ozone into the groundwater to treat both contaminated groundwater and soil.	Potentially applicable.
	Enhanced Bioremediation	• Addition of nutrients into the subsurface to promote biodegradation of chlorinated VOCs.	Potentially applicable.
	Permeable Reactive Barriers (PRBs)	• Permeable barrier installed across the flow path of a contaminated groundwater plume. • Contaminants are either chemically degraded (treated) and/or retained in a concentrated form by the barrier material.	Potentially applicable.

2.3.1 Identification of Potential Technologies/Process Options

This section identifies the technologies and process options that are considered potentially applicable for the Southington Site.

No Action

Under No Action, no groundwater measures would be taken to address constituents in groundwater. No Action is required to be considered under the NCP. The No Action option for groundwater is retained for further evaluation.

Institutional Controls

Institutional controls, such as Environmental Land Use Restrictions ("ELURs"), could be used to prevent construction of structures where exceedances of residential and/or commercial/industrial volatilization criteria have occurred, unless appropriate engineering controls are put in place. These controls are easy to implement. Exposure to VOC volatilizing from groundwater at concentrations exceeding remediation goals would be effectively prevented. Therefore, institutional controls are potentially appropriate and are retained for further evaluation.

Monitoring

Monitoring of groundwater would be used to determine where measures would need to be taken to address the CT RSRs as well as to confirm in the future that no additional measures are required as groundwater moves down gradient from the Site. Groundwater monitoring is potentially appropriate and is retained for use as a component of remedial alternatives evaluated in the AFS.

Engineering Controls – Building Ventilation

Building ventilation controls (such as subslab depressurization) could be used to either prevent migration of VOC vapors into, or control the level of VOCs in vapor beneath or in, any existing buildings located on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs residential or commercial/industrial volatilization criteria. Building ventilation controls are low cost and easy to implement and maintain. By removing or controlling VOCs in vapors beneath or in an existing building, exposure to VOCs volatilizing from groundwater at concentrations exceeding remediation goals would be effectively prevented. Building ventilation is potentially appropriate and is retained for further evaluation.

Engineering Controls – Vapor Barriers

Vapor barriers could be used to prevent infiltration of VOCs in vapors beneath existing or future buildings located on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs residential or commercial/industrial volatilization criteria. Installation of a vapor barrier beneath an existing building is difficult to implement and has a moderate to high cost to implement. Although, by preventing VOCs in vapors beneath a building from infiltrating into the building, exposure to VOCs volatilizing from groundwater at concentrations exceeding remediation goals would be effectively prevented, the use of vapor barriers on existing buildings would result in significant disruption to the commercial activity. However, vapor barriers can be readily constructed under new buildings and can effectively prevent exposure to VOCs. Vapor barriers are potentially appropriate and are retained for further evaluation.

Containment

Containment actions control or reduce migration of the contaminated materials into the surrounding environment. They could also be used to isolate contaminated soil and groundwater to reduce the possibility of exposure by direct contact. These actions may involve the use of physical barriers to block a contaminant migration pathway. Containment measures for contaminated groundwater typically include caps, hydraulic gradient controls, vertical barriers, and horizontal barriers. Containment is potentially appropriate for consideration at the Southington Site and is retained for further evaluation.

Groundwater Pump-and-Treat

A groundwater treatment facility (GWTF) is used to reduce groundwater contaminant levels more rapidly than plume containment or monitored natural attenuation to prevent further plume migration. A groundwater extraction system, using pumping wells or extraction trenches, removes contaminated groundwater from the affected aquifer, followed by treatment and subsequent discharge to a surface water body, local publicly-owned treatment works (POTW) or reinjection of treated groundwater back into the local aquifer. Above ground treatment of the extracted groundwater may involve physical and chemical processes such as air stripping, carbon adsorption, and biological treatment, depending on the physical and chemical properties of the contaminants. A number of relatively large-scale pump and treat approaches for the groundwater plume at OSL were previously considered during the 1993 FS. Groundwater pump and treat options are potentially appropriate at the Southington Site and are retained for further evaluation.

Air Sparging/Soil Vapor Extraction

Air sparging (AS) and soil vapor extraction (SVE) may be used in combination or SVE may be used as a stand-alone process. AS involves injecting air into the aquifer to strip or flush volatile contaminants. As air bubbles up through the groundwater, it is captured by an SVE (vacuum) system installed above ground. Stripped or volatilized contaminants removed through SVE wells are usually treated in an above ground vapor treatment system prior to being discharged to the ambient air, with collected condensate captured and discharged following some form of treatment similar to the GWTF described above. Air sparging/soil vapor extraction is potentially appropriate and is retained for further evaluation.

Total Fluids Extraction

Total fluids extraction, also known as multi-phase extraction is essentially a combination of groundwater extraction and SVE. Utilizing this method, an extraction system is designed to extract both liquids (groundwater and non-aqueous phase liquids) and vapors from the local subsurface, then separating the phases and treating each in an aboveground treatment system prior to local discharge. Total fluids extraction technologies are potentially appropriate and are retained for further evaluation.

Thermal Treatment

In-situ thermal treatment methods are used to mobilize contaminants in the subsurface through heating the targeted groundwater and soil, either degrading the contaminants through the application of heat or removing the contaminants by vapor or water extraction. Thermal treatment technologies are potentially appropriate and are retained for further evaluation.

Chemical Oxidation

In-situ chemical oxidation (ISCO) technology involves pumping a chemical such as hydrogen peroxide, potassium permanganate, or ozone into the subsurface through injection wells to break down the organic contaminants into non-hazardous compounds. Chemical oxidation technologies are potentially appropriate and are retained for further evaluation.

Biological Remediation

In-situ biological degradation facilitates biological destruction of the contaminants by adding biological or chemical agents to the subsurface through injection wells. In-situ groundwater bioremediation includes adding bacterial nutrients, an oxygen source (such as air), chemicals to change redox conditions or the introduction of specific bacterial species into the aquifer to enhance biodegradation of contaminants in the groundwater. Biological remediation technologies are potentially appropriate and are retained for further evaluation.

Passive Treatment Barriers

Passive reactive barriers (PRBs) are usually passive treatment walls that facilitate chemical or biological destruction. PRBs function as a contaminant treatment zone, when contaminated groundwater comes into contact with the wall, which is permeable, a chemical reaction takes place. The walls are placed in the subsurface across the natural flow path of the contaminant plume. They can also be combined with impermeable flow barriers (slurry walls or sheet piling) in a "funnel-and-gate" arrangement, in which flow is directed through the treatment walls or "gates." PRBs can be keyed into low permeability stratum (i.e. bedrock) to provide more complete capture or built as "hanging" walls to provide treatment to only the upper portions of the aquifer. Any groundwater that underflows a "hanging" wall would be driven to the lower portions of the aquifer. Passive treatment barrier technologies are potentially appropriate and are retained for further evaluation.

2.3.2 Screening of Potential Remedial Technologies/Process Options

In order to develop alternatives, the technologies/process options that are potentially appropriate are screened against three criteria: effectiveness, implementability, and cost. The screening criteria, as defined in the NCP, are as follows.

Effectiveness

This criterion focuses on the degree to which an alternative reduces toxicity, mobility or volume through treatment; minimizes residual risks and affords long-term protection; complies with ARARs; minimizes short-term impacts; and minimizes the time to achieve cleanup. Alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration (EPA, 1994).

Implementability

This criterion focuses on the technical feasibility and availability of technologies each alternative would employ and the administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period may be eliminated from further consideration (EPA, 1994).

Cost

This criteria focuses on the costs of construction and any long-term costs to operate and maintain the alternatives. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated (EPA, 1994).

2.3.2.1 No Action

The No Action option, required under the NCP, provides a baseline for comparing other options and/or alternatives. This option entails no future activities to contain or remediate contaminants at OSL, provides no treatment for contaminants, and provides no legal or administrative protection of human health or the environment beyond cleanup criteria. This option assumes that physical conditions at OSL remain unchanged.

Effectiveness

The No Action option is not effective in remediating the contaminated groundwater at OSL and in meeting the RSRs with regard to protection of human health and the environment. However, the No Further Action option is retained for detailed evaluation to serve as a baseline for comparison for other options and/or alternatives.

Implementability

The No Action option is easy to implement technically, because it does not require any actions to be taken.

Cost

There are no construction or operations and maintenance costs associated with the No Action option because no actions are taken and no long-term site monitoring is conducted. However, it is anticipated that periodic CERCLA five-year reviews would be conducted under this option to evaluate conditions at OSL as required by the NCP. Costs associated with the 5-year reviews would be included in the No Action option.

Screening Summary

The No Further action option will not achieve RSRs; however, it is retained as a stand-alone alternative to be used as a baseline against which other alternatives will be compared.

2.3.2.2 Institutional Controls

Institutional controls, such as Environmental Land Use Restrictions ("ELURs"), could be used to address prevent construction of structures where exceedances of residential and/or commercial/industrial volatilization criteria have occurred unless appropriate engineering controls are put in place.

Effectiveness

Exposure to VOCs in vapor resulting from volatilization from groundwater would be prevented through the use of ELURs on any parcel of land or portion thereof overlying areas where groundwater impacted by the Site exceeds the CT RSRs residential or commercial/industrial volatilization criteria. As a result, this alternative does not reduce toxicity, mobility or volume through treatment and does not minimize residual risks nor does it reduce the time to achieve acceptable levels in the groundwater. It does however, afford long-term protection, comply with ARARs and has no unacceptable short term impacts. As a result, this alternative does provide adequate protection of human health and the environment. Its overall effectiveness is typically a function of how well compliance with these institutional controls is monitored and enforced.

Implementability

This option is easily implementable because it involves the use of accepted institutional controls. Institutional controls are commonly used in Connecticut to address similar issues.

Cost

The cost of this option is low.

Screening Summary

As a result, the Institutional Control Option is retained for further evaluation.

2.3.2.3 Monitoring

Monitoring of groundwater would be used to determine where measures would need to be taken to address the CT RSRs as well as to confirm in the future that no additional measures are required as groundwater migrates.

Effectiveness

Exposure to VOCs in vapor resulting from volatilization from groundwater would not be prevented through monitoring. As a result, this option does not reduce toxicity, mobility or volume through treatment and does not minimize residual risks nor does it reduce the time to achieve acceptable levels in the groundwater. It does not afford long-term protection or comply with ARARs. It has no unacceptable short term impacts. As a result, this alternative alone does not provide adequate protection of human health and the environment. However, this option when used in conjunction with other engineered controls or active remediation technologies would be effective in determining whether or not those alternatives are effective in protecting human health and the environment.

Implementability

Since groundwater monitoring is on going under the Long-Term Monitoring Plan, continuation of the appropriate level of monitoring is easily implemented.

Cost

The cost of this option is low.

Screening Summary

As a result, Monitoring is retained for further evaluation in combination with other options.

2.3.2.4 Engineering Controls – Building Ventilation

Building ventilation controls (particularly subslab depressurization) could be used to either prevent migration of VOC vapors into, or control the level of VOCs in vapor beneath or in, any existing buildings located on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs residential or commercial/industrial volatilization criteria. Building ventilation controls are low cost and easy to implement and maintain. By removing or controlling VOCs in vapors beneath or in an existing building, exposure to VOC volatilizing from groundwater at concentrations exceeding remediation goals would be effectively prevented.

Effectiveness

This option allows for the use of building ventilation for existing buildings in areas where the CT RSRs commercial/industrial volatilization criteria are exceeded, consistent with the CT RSRs. This option is effective in preventing exposure from VOCs in vapor beneath or in any existing buildings located in areas where the VOC concentrations in groundwater exceed the CT RSRs commercial/industrial volatilization criteria, by using building ventilation controls to either prevent migration of VOC vapors into, or control the level of VOC in vapors beneath and in, any existing buildings. As a result, this option does not reduce toxicity, mobility or volume through treatment and does not minimize residual risks nor does it reduce the time to achieve acceptable levels in the groundwater. It does however, afford long-term protection, comply with

ARARs and has no unacceptable short-term impacts. As a result, this alternative does provide adequate protection of human health and the environment.

Implementability

This option is easy to construct and is particularly well suited for existing buildings. This option does not present any significant implementation issues.

Cost

The cost of this option is low to moderate.

Screening Summary

As a result, building ventilation is retained for further evaluation in situations where existing buildings are addressed.

2.3.2.5 Engineering Controls – Vapor Barriers

Vapor barriers could be used to prevent infiltration of VOC in vapors beneath newly constructed buildings located on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs residential or commercial/industrial volatilization criteria. Preventing VOCs in vapors beneath a building from infiltrating into the building, exposure to VOCs volatilizing from groundwater at concentrations exceeding remediation goals would be effectively prevented under this option. This option is best suited for new construction.

Effectiveness

This option allows for the use of vapor barriers in areas where the CT RSRs commercial/industrial volatilization criteria are exceeded, consistent with the CT RSRs. This option is effective in preventing VOCs in vapors beneath a building from infiltrating into the building from areas where the VOC concentrations in groundwater exceed the CT RSRs commercial/industrial volatilization criteria. As a result, this option does not reduce toxicity, mobility or volume through treatment and does not minimize residual risks nor does it reduce the time to achieve acceptable levels in the groundwater. It does however, afford long-term protection, comply with ARARs and has no unacceptable short-term impacts. As a result, this alternative does provide adequate protection of human health and the environment.

Implementability

This option is easy to construct and is particularly well suited for areas where no buildings currently exist but where buildings are planned in the future. This option does not present any significant implementability issues other than previously described.

Cost

The cost of this option is low to moderate.

Screening Summary

As a result, vapor barriers are retained for further evaluation in situations where new construction takes place.

2.3.2.6 Containment with Horizontal Barriers

Containment actions control or reduce migration of the contaminated materials into the surrounding environment. They can also be used to isolate contaminated soil or groundwater to reduce the possibility of exposure by direct contact. These actions may involve the use of physical barriers to block a contaminant migration pathway, such as a soil-to-groundwater pathway. Containment actions for contaminated groundwater typically include physical barriers or hydraulic gradient controls. A form of horizontal barrier containment in the source area currently exits at OSL by way of the landfill cap that prevents infiltration of surface water through contaminated soils into the local groundwater aquifer.

Effectiveness

Horizontal barriers or additional capping at OSL could significantly reduce migration of contaminants from soil to groundwater due to infiltration of surface water. However, sources would remain at and below the groundwater table and continue to affect groundwater in the source areas. Therefore, RSRs would not be achieved in the source areas using caps alone. Capping could also have a negative effect of reducing oxygen availability in the area by reducing the infiltration of oxygenated precipitation. By cutting off contact of atmospheric air with the vadose zone and shallow groundwater, capping could reduce the degree of aerobic degradation occurring in the area and increase the degree of anaerobic degradation. However, there are tradeoffs with both anaerobic and aerobic degradation, therefore additional containment is ranked as being of limited effectiveness.

Implementability

Capping as was previously performed at OSL is considered a standard construction practice and easily implemented. Equipment and construction methods associated with capping are readily available, and design methods and requirements are well understood. However, capping areas downgradient of the site would have serious implementability issues related to ongoing land use.

Cost

An additional conventional cap at specific Site areas would have a moderate cost to construct and a comparatively low maintenance cost.

Screening Summary

As has been shown by the limited effectiveness of the existing cap at OSL, containment with physical barriers alone would not achieve RSRs within or downgradient of the source areas. Additional caps are not retained due to potential adverse effects to subsurface and groundwater chemistry, and the serious implementability issues associated with them.

2.3.2.7 Containment With Vertical Barriers

Physical containment methods to vertically isolate movement of groundwater at OSL could include sheet piling and cutoff walls or curtains. These types of physical barriers could be used in conjunction with in-situ treatment walls or gates commonly referred to as permeable reactive barriers.

Effectiveness

For a vertical groundwater barrier to be completely effective at OSL, it would need to fully isolate the contaminated portion of the aquifer, both laterally and vertically. This would require keying the barrier into the top of the bedrock that underlies the shallow aquifer. However, it is typically problematic to completely seal sheet piling to undefined bedrock. Also, a vertical barrier may need to completely encircle the targeted area to preclude any groundwater flow around the barrier. Effective containment of groundwater at the source areas by vertical physical barriers would allow cleanup of downgradient groundwater using other remedial actions; however, containment by itself would not remediate source areas to achieve RSRs and is therefore ranked as being of limited effectiveness, as a stand alone option.

Implementability

Groundwater containment can be difficult to achieve; however, these actions have been successfully implemented at other, similar sites. Groundwater containment using vertical barriers at OSL may be somewhat difficult to implement due to limited available locations for installation and greater depths to groundwater and bedrock in certain areas. Changing seasonal flow directions can also interfere with containment of contaminated groundwater. Therefore, groundwater containment is ranked as being moderately difficult to implement at OSL.

Cost

It is projected that vertical groundwater barriers at OSL would have a moderate to high cost to construct. However, maintenance costs of vertical groundwater barriers are considered comparatively low.

Screening Summary

Containment with physical barriers alone would not achieve RSRs within the source areas; however, containment could be an integral part of remedial approach to clean up groundwater downgradient of source areas. Therefore, vertical groundwater containment is retained in conjunction with other options to form remedial alternatives at OSL.

2.3.2.8 Groundwater Pump-and-Treat

Groundwater pump-and-treat consists of collection, treatment and discharge of contaminated groundwater. Pump-and-treat is used to provide hydraulic containment and/or to reduce groundwater contaminant levels in a portion of the plume. An extraction system is used to remove contaminated groundwater from the affected aquifer, which is typically followed by groundwater treatment and subsequent discharge to surface waters or reinjection of the groundwater back into the aquifer. Extraction can be achieved by using pumping wells, French drains, or extraction trenches. Pump-and-treat technologies can be used to either remediate or restore an aquifer to original groundwater quality conditions, or to maintain hydraulic control to prevent migration of the leading edge of a contaminant plume or prevent future release of source materials beyond a hydraulic barrier.

Effectiveness

Extraction wells are effective in intercepting and extracting groundwater. Collection trenches are effective for shallow formations. Groundwater modeling should normally be used to determine details of pump-and-treat effectiveness. However, based on similar site experience, it is projected that pump-and-treat alternatives may be effective at OSL although considerable time may be required to meet and maintain cleanup goals. Pump-and-treat technology could be used to effectively maintain hydraulic control to minimize future migration of contaminated groundwater downgradient of the landfill source areas.

Implementability

Extraction wells are relatively easy to construct and are a proven and widely available technology. Collection trenches are considered to be moderately easy to implement for shallow groundwater collection. At OSL, treatment facilities could be constructed. However, they would likely need to be constructed on off-site properties downgradient of the site itself. The space required to construct a treatment facility would likely create significant land use sconflicts since the downgradient properties are privately owned. In addition, at OSL discharge of treated water may be a significant problem as only limited discharge options appear to be available. It may be necessary to discharge treated water via new piping to the Quinnipiac River (one half mile away), generating significant implementability issues.

Cost

Pumping and treatment costs are considered relatively to high and depend on the number of wells or trenches that must be installed and the treatment system that is utilized. In addition, long-term O&M costs are also expected to be relatively high due to the need to closely monitor above ground treatment system operation. If off-site discharge to the Quinnipiac River were required, costs would further significantly increase.

Screening Summary

Pump-and-treat scenarios using extraction wells and collection trenches may achieve RSRs within the contaminated portions of the aquifer. However, implementation issues associated with treatment facility location/construction on privately owned downgradient properties, and groundwater discharge (potentially to the Quinnipiac River) are major concerns. In addition, the high costs of both system construction and particularly system O&M in conjunction with the predicted extensive duration of system operation makes this option less implementable and more costly than other alternatives. Thus, pump-and-treat at OSL will not be retained for further consideration.

2.3.2.9 Air Sparging/Soil Vapor Extraction

AS/SVE is a process where air is injected into the saturated zone below or within the areas of groundwater contamination while simultaneously applying a vacuum to vapor extraction wells (horizontal or vertical) to induce air flow through the contaminated vadose zone soil. As the injected air rises through the saturated zone, it tends to volatilize and remove adsorbed VOCs in soil as well as strip dissolved contaminants from groundwater. AS also oxygenates the groundwater, thereby enhancing the potential for biodegradation at sites with contaminants that degrade aerobically, such as at OSL. Extracted vapors may then be treated as necessary and discharged to the ambient air. AS/SVE can be constructed to treat a specific zone or area of contamination or it may be constructed as a barrier using horizontal or vertical injection wells perpendicular to the flow of groundwater.

Effectiveness

AS/SVE is an effective and commonly used technology for remediation of both saturated and unsaturated zones (groundwater and soil) contaminated with VOCs, including the chlorinated VOCs found at OSL. The ability of AS/SVE to meet RSRs in a reasonable timeframe is dependent upon the nature and extent of contaminant source material. Specifically, at OSL, the effectiveness of AS/SVE could be challenged by the need to treat a relatively wide plume (and the associated area) leaving the landfill to meet low level CT RSRs. Additionally, AS can cause groundwater mounding that could change the groundwater gradients and potentially accelerate or alter plume migration. Groundwater mounding would be undesirable at OSL particularly if it resulted in contaminated groundwater recharge to the Unnamed Stream.

Implementability

AS and SVE are technologies with well documented full-scale applications. Large AS/SVE systems require significant equipment installation, power input, and routine maintenance. AS/SVE is considered to be very difficult to implement at OSL, depending upon aquifer depths and the presence of existing structures and other physical constraints that could inhibit component installation. AS could not be used to treat source areas which are covered by the existing cap. In addition, existing buildings immediately downgradient of the landfill may interfere with installation of an appropriate extraction well array. The off-gas and condensate collected as the result of AS/SVE would require additional treatment to collect or destroy extracted organic contaminants.

Cost

The cost of implementing AS/SVE, including installation of air lines, sparge points, extraction points and equipment shelters, is considered relatively high depending upon the complexity of the AS/SVE network. Since AFS is an active treatment system requiring close monitoring, long-term O&M costs would also be high in order to maintain compliance with RSRs.

Screening Summary

Concerns with applying AS/SVE at OSL include challenges in treating a relatively lengthy landfill frontage, implementability concerns related to downgradient structures and utilities, and both relatively high construction and high O&M costs. Given these effectiveness, implementability and cost issues combined with the fact that other treatment options are available that are more effective and more easily implemented AS/SVE at OSL will not be retained for further consideration.

2.3.2.10 Total Fluids Extraction

Total fluids or MPE is basically a combination of groundwater extraction and SVE. Utilizing this method, an extraction system is designed to extract both liquids (groundwater and non-aqueous phase liquids) and vapors from the local subsurface, then separating the phases and treating each in an above ground treatment system prior to local discharge.

Effectiveness

Similar to pump-and-treat and AS/SVE, MPE is an effective and commonly used technology for remediation of both saturated and unsaturated zones contaminated with VOCs, including the chlorinated VOCs found at OSL. The ability of MPE to meet RSRs in a reasonable timeframe is also dependent upon the nature and extent of contaminant source material.

Implementability

Large scale MPE systems require significant equipment installation, power input, and routine maintenance. MPE is considered to be very difficult to implement at OSL, depending upon aquifer depths and the presence of existing structures and other physical constraints that could inhibit component installation. Both the extracted liquids and off-gas extracted as the result of MPE would require additional treatment. Treatment of groundwater extracted by MPE would require the construction of above ground facilities probably on downgradient private properties, potentially creating land use conflicts. In addition, as for other groundwater extraction technologies discharge of treated groundwater is a potentially significant problem. Groundwater may need to be discharged to the Quinnipiac River (approximately 0.5 miles away). This would require extensive pipe installation and could create significant implementability issues.

Cost

The cost of implementing MPE is similarly considered moderate to high depending upon the complexity of the MPE network. This system would require considerable ongoing monitoring to maintain operational efficiency and conformance with RSRs. As such, the cost of system long-term O&M would also be relatively high.

Screening Summary

As with other groundwater extraction systems, a number of significant concerns exist. These include land use and implementability issues related to construction of treatment facilities on private downgradient properties and the potential need to discharge treated water to the Quinnipiac River. In addition these factors coupled with relatively high construction costs and high long-term O&M costs associated with the need for extensive system monitoring, make this option less implementable and more costly than other treatment options. Thus, MPE at OSL will not be retained for further consideration.

2.3.2.11 In-Situ Thermal Treatment

In-situ thermal treatment methods include steam injection, six-phase heating, and radiofrequency heating of the subsurface. Thermal treatment is typically used in saturated zone areas where high concentrations of NAPL-contaminated soil or mobile NAPL are present. Neither high concentrations of NAPL-contaminated soil nor mobile NAPL have been confirmed at OSL. The increased temperatures help to volatilize VOCs and enhance in-situ oxidation. Vaporized contaminants rise to the unsaturated zone where they are removed by an SVE network and then treated in a vapor treatment system.

Effectiveness

Thermal treatments are effective in removing oily waste accumulations and in retarding downward and lateral migration of organic contaminants. It is most effectively applied to sites with soil containing light to dense NAPLs, including VOCs and could be effective at treating higher contaminated zones at OSL.

Implementability

Thermal treatments are applicable to both shallow and deep contaminated areas. In addition, the components of the technology are readily available. However, locations near existing downgradient operating facilities and structures and installation without undermining the existing OSL cap would make this technology very difficult to construct.

Cost

Thermal treatments are expensive technologies and are generally considered cost effective only at sites with very high dissolved contaminant concentrations and/or mobile NAPL. The cost of implementing, operating and maintaining thermal treatment at OSL is projected to be relatively high.

Screening Summary

Mobile or recoverable NAPL has not been found at OSL. Contaminated zones of groundwater are found primarily in the shallow zone where other in-situ treatment technologies (SVE) can be applied with similar or greater effectiveness and lower cost therefore, in-situ thermal treatments are eliminated from further consideration.

2.3.2.12 Chemical Oxidation

ISCO involves the injection of a chemical oxidant such as hydrogen peroxide, potassium permanganate, sodium permanganate or ozone into the groundwater to treat both contaminated groundwater and soil. Chemical oxidation of VOCs can produce hydrochloric acid and carbon dioxide.

Effectiveness

ISCO is effective at treating chlorinated VOCs. However subsurface impediments such as low conductivity clay lenses and subsurface chemical reactions can make it difficult to deliver the oxidant to the targeted contaminant. Natural organic matter in the aquifer, other organic contaminants (petroleum), and dissolved iron can consume applied oxidants. The presence of a large mass of other organic materials (including peat deposits) at OSL may limit the effectiveness of chemical oxidation at treating chlorinated VOCs. In addition, the application of strong chemical oxidants could potentially impact the mobility of metals in groundwater downgradient of OSL. The exact nature of the impacts is difficult to assess but might result in some metals being mobilized from their current fixed locations.

Implementability

Chemical oxidation is applicable to both shallow and deep contaminated areas and is considered to be easy to implement at OSL. In addition, as a widely used and proven technology, ISCO components are readily available.

Cost

The number of injection wells needed and volume of oxidant required for injection directly affect cost for ISCO. The cost of implementing, operating and maintaining chemical oxidation at OSL is considered to be moderate to relatively high.

Screening Summary

The complex nature of the OSL plume and existing cap integrity concerns makes this technology less effective than other treatment technologies. Thus, ISCO will not be retained for further consideration at OSL.

2.3.2.13 Enhanced Bioremediation

Enhanced bioremediation involves addition of nutrients or substrate into the subsurface to promote biodegradation of chlorinated VOCs in groundwater. Under anaerobic conditions, certain bacteria are able to gain energy for growth by reducing chlorinated VOCs such as tetrachloroethene (PCE) and TCE. Lactate has been successfully used to enhance anaerobic biodegradation at other similar sites. However, its use assumes that the preexisting population of anaerobic organisms is sufficiently large to degrade chlorinated VOCs if provided a sufficient electron donor and that redox conditions can be maintained that will encourage microbial reactions. In some cases, selected species of microorganisms are injected to colonize areas.

Oxygen-enhanced aerobic bioremediation entails the addition of oxygen to the groundwater to facilitate more rapid biological degradation of contaminants. Oxygen enhancement can be accomplished by several methods, including air sparging or the addition of an electron acceptor such as hydrogen peroxide. Aerobic biodegradation can be promoted by the addition of oxygen into a contaminated area to provide an electron donor to the existing in-situ population of dechlorinating microorganisms. Also, organic carbon may be introduced into the contaminated area to provide a growth substrate to culture and enhance the population. PCE degradation generally occurs anaerobically and microbes can then use in-situ oxygen or injected oxygen enhancements to aerobically degrade available compounds such as the breakdown of PCE to TCE to 1,2-DCE and finally vinyl chloride. Oxygen enhancement is most effective to enhance complete degradation of vinyl chloride; the other degradation products such as TCE and 1,2-DCE are more effectively reduced using anaerobic processes.

Effectiveness

Bioremediation can potentially be effective for small sites with shallow depths to groundwater, such as downgradient hot spots at OSL. Also, bioremediation does not generate vapor emissions that would need to be collected and treated. The effectiveness of bioremediation can be limited by the presence of clay lenses in the aquifer, as a layer of clay will impede the movement of additive compounds through the contaminant mass in the saturated area. Slow groundwater velocities will also limit the distribution and require a large number of injection points. Anaerobic enhancement using lactate may be used as part of a phased approach for in-situ remediation of the chlorinated VOCs including PCE, TCE, and cis-1,2-DCE. Often, cis-1,2-DCE and vinyl chloride (VC) are treated in-situ using an aerobic oxygen enhancement process that may reduce the contaminants cis-1,2-DCE and VC to meet RSRs; however, the time needed varies based upon contaminant concentrations and hydrogeologic conditions. Pilot testing at OSL would be required to define reaction rates and identify areas of possible in-situ bioremediation. However, based upon monitored natural attenuation data gathered at OSL during SGI studies, it is presumed that the achievable degradation rate and the effectiveness of the treatment are limited.

Implementability

Implementation of bio-enhancement is considered to be relatively easy at OSL source areas. In addition, bioremediation produces minimal residual waste and requires little above ground equipment and power input. Typically, pilot testing is performed prior to full-scale implementation of bioremediation at a site. Reaction rates, influence areas, and other design parameters would be determined using the results and data from the pilot test. Limitations for anaerobic remediation involved with the use of lactate or time-release compounds include the possibility of hydrogen sulfide gas production that can pool in areas and displace oxygen. The generation of hydrogen sulfide gas is usually only of concern at sites where groundwater sulfate levels are excessively high (>600 mg/L), which is generally not the case at OSL. Finally, the presence of the cap may present significant implementability issues.

Cost

The cost of implementing bio-enhancement is low to moderate. Factors influencing cost include depth of contamination, quantity of injection points needed for areal coverage, and cost of initial pilot testing. Cost of O&M is projected to be relatively low.

Screening Summary

Aerobic or anaerobic enhancement alone is not considered appropriate for OSL because groundwater contaminants at the site include the more highly chlorinated VOCs PCE and TCE, which biodegrade more effectively in an anaerobic environment and the lesser chlorinated vinyl chloride, which biodegrades more effectively in an oxygen-rich environment. The somewhat diffuse nature of the OSL plume and the presence of the landfill cap over plume source term areas make this option less effective and implementable than other treatment options. Thus, bio-enhancement at OSL will not be retained for further consideration.

2.3.2.14 Permeable Reactive Barriers

PRBs, also known as passive treatment walls, are installed perpendicular to the flow path of a contaminated groundwater plume, allowing groundwater to flow through the wall. These barriers allow the passage of groundwater while removing contaminants of concern by employing agents within the wall such as zero-valent metals. The contaminants are either degraded or retained in a concentrated form within the barrier material, which may need to be replaced periodically. PRBs are a passive technology in that groundwater is treated in-situ. Thus groundwater is not extracted and above ground treatment facilities are not required.

For the VOC plumes at OSL, a PRB would likely be constructed with a reactive medium such as zero-valent iron. As the VOC plume migrates downgradient, it crosses the barrier and reacts with the iron, causing chlorinated VOCs to be completely and nonselectively oxidized to ethene, ethane, and water. Commercial permeable reactive barriers are currently built in two basic configurations continuous, funnel-and-gate and continuous.

Continuous systems are literally continuous reactive barriers of varying thickness and depth. The funnel-and-gate design uses physical barrier walls (such as sheet pilings or slurry walls) as a “funnel” to direct the contaminant plume to a “gate” containing the reactive media, whereas the continuous barrier completely transects the plume flow path with reactive media. Due to the funnels, the funnel-and-gate design has a greater impact on altering the groundwater flow than does the continuous permeable reactive barrier. In both designs, it is appropriate to try to keep the reactive zone permeability equal to or greater than the permeability of the aquifer, to minimize diversion of the groundwater around the reactive zone.

Effectiveness

Reactive iron barriers have been successful in dechlorinating VOCs such as those found at OSL. The barrier acts to cut off the flow of contaminated groundwater; however, the barrier does not treat the source area. Effectiveness would target shallow groundwater since keying the barrier into the top of the bedrock (120 ft bgs) at OSL and sealed to prevent groundwater bypass is technically impractical.

Previous studies of zero-valent iron reactive barriers have indicated that precipitates may form over time on the iron as the groundwater passes through the reactive wall, but it is uncertain how much of the precipitate stays in the wall. These precipitates, as well as the potential occurrence of biofouling, could eventually decrease permeability of the wall and increase water flow under the permeable reactive barrier. The current technology for barrier regeneration involves the removal and replacement of the zero-valent iron when conditions indicate the reactivity of the wall has been spent.

PRBs installed at sites with similar groundwater contaminants have been effective at removing chlorinated VOCs from groundwater to below detection limits, and are predicted to perform acceptably for at least 30 years. Based on historical results, a PRB is expected to be effective at treating VOCs in groundwater at OSL.

Implementability

Many PRBs have been installed utilizing common continuous trenching techniques, the components of the technology are readily available. In addition, the passive nature of the barrier makes O&M relatively easy. The relatively narrow width of PRBs and the absence of above ground treatment facilities reduces their impacts to land use on downgradient properties. Additionally installation at OSL may be warranted as several PRBs located in strategic areas at OSL possibly with selected funnel (sheet piles or slurry walls) in-between to target highest areas of shallow groundwater remediation. However, PRBs would be moderately difficult to construct at OSL because of the presence of utilities in Old Turnpike Road (immediately downgradient of the landfill) and elevated surface terrain immediately west of the road. At OSL the depth to bedrock would require construction of a “hanging” wall PRB configuration. This alternative is considered of moderate difficulty to implement at OSL for shallow groundwater remediation in a “hanging” wall configuration.

Cost

Costs for PRBs are directly dependent on the size of the reactive barrier that must be installed, and the size (length, depth, and thickness) of the reactive barrier depend directly upon contaminant concentrations, plume width, and groundwater velocity, size, and migration rate of the groundwater plume. The cost of implementing reactive barriers for shallow groundwater remediation at OSL is considered moderate to high. However, O&M costs are considered to be low, due to the absence of above ground treatment processes to monitor.

Screening Summary

There would be certain implementability challenges associated with constructing a PRB immediately downgradient of the OSL site, although this option presents fewer implementability issues than the other alternatives that are equally effective. Also construction costs would be moderate to high. However, a PRB is expected to reduce shallow groundwater VOCs to below CT RSR values over time. In addition, since PRBs involve in-situ treatment, they would require no significant above ground treatment structures/facilities, would not have post-treatment groundwater discharge issues, and would have little routine maintenance and low associated O&M costs. Based upon these features, PRBs are retained for further evaluation.

3.0 DEVELOPMENT AND INITIAL SCREENING OF REMEDIAL ALTERNATIVES

In this section, remedial technologies and representative process options remaining after the preliminary screening process are combined to form remedial alternatives. The alternatives developed are initially screened against three criteria: effectiveness, implementability, and cost (Section 3.2).

3.1 Development of Remedial Alternatives

The remedial technologies from Section 2 are combined to form remedial alternatives. The alternatives are designed to: 1) meet the remedial response objectives; and 2) represent a range of technology options, where possible.

Three remedial alternatives have been developed to address groundwater:

- **Alternative GW1: No Action**
  No action would be taken under GW1. As required by the NCP, the No Action alternative is carried through the detailed analysis for comparative purposes.
- **Alternative GW2: Institutional Controls/Groundwater Monitoring/Building Ventilation (Subslab Depressurization)/Vapor Barriers**
  Alternative GW2 includes institutional controls, in the form of ELURs, to address exceedances of the CT RSRs residential or commercial/industrial volatilization criteria (also denoted as volatilization or vapor intrusion criteria), as appropriate. Institutional controls meeting the CT RSRs volatilization criteria will require some level of groundwater monitoring to demonstrate compliance. GW2 allows for the use of building ventilation (subslab depressurization) for existing commercial/industrial buildings located in areas covered by ELURs and where the commercial/industrial CT RSRs volatilization criteria are exceeded, consistent with the CT RSRs. This alternative also allows for the use of vapor barriers to prevent vapor intrusion into new buildings.
- **Alternative GW3: Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers**
  Alternative GW-3 includes installation of a permeable reactive barrier (PRB) to treat VOC contaminated groundwater to levels below the CT RSRs for volatilization. Alternative GW3 also includes institutional controls, in the form of ELURs, to address exceedances of the CT RSRs volatilization criteria, as appropriate. GW3 also allows for the use of building ventilation (subslab depressurization) for existing commercial/industrial buildings located in areas covered by ELURs and where the CT RSRs volatilization criteria are exceeded, consistent with the CT RSRs. This alternative also allows for the use of vapor barriers to prevent vapor intrusion into new buildings.

3.2 Initial Screening of Remedial Alternatives

In order to select the alternatives that will undergo a detailed evaluation, the alternatives developed in Section 3.1 are screened against three criteria: effectiveness, implementability, and cost. The screening criteria, as defined in the NCP, are as follows:

Effectiveness: This criterion focuses on the degree to which an alternative reduces toxicity, mobility or volume through treatment; minimizes residual risks and affords long-term protection; complies with ARARs; minimizes short-term impacts; and minimizes the time to achieve cleanup. Alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration (EPA, 1994).

Implementability**:** This criterion focuses on the technical feasibility and availability of the technologies each alternative would employ and the administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period may be eliminated from further consideration (EPA, 1994).

Cost: The costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated (EPA, 1994).

The screening for the potential remedial alternatives is presented below. For each alternative, the major components are identified, and an evaluation of the effectiveness, implementability and estimated order-of-magnitude cost are presented. The results of the initial screening of each alternative are also presented, along with the justification for the screening decision.

3.2.1 **Alternative GW1: No Action**

3.2.1.1 Description – Alternative GW1 – No Action

No remedial action would be taken under Alternative GW1.

3.2.1.2 Effectiveness – Alternative GW1 – No Action

Under Alternative GW1, volatilization of VOCs from groundwater would not be addressed through active remedial measures and no institutional controls would be put in place. This alternative would not prevent exposure to VOCs in vapor resulting from volatilization from groundwater.

As a result, this alternative does not reduce toxicity, mobility or volume through treatment; does not minimize residual risks and or afford long-term protection; or comply with ARARs; does not minimize short-term impacts or the time to achieve acceptable levels in the groundwater. As a result, this alternative does not provide adequate protection of human health and the environment.

3.2.1.3 Implementability – Alternative GW1 – No Action

Alternative GW1 could be easily implemented, since it would require no measures to be taken.

3.2.1.4 Cost – Alternative GW1 – No Action

There would be minimal costs associated with Alternative GW1, primarily related to the performance of five-year reviews.

3.2.2 **Alternative GW2 – Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers**

3.2.2.1 Description – Alternative GW2 - Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Under Alternative GW2, the following measures would be implemented:

1. Institutional controls in the form of ELURs on properties or portions of properties where groundwater VOC concentrations exceed the CT RSR volatilization criteria, to remain in place as long as groundwater VOC concentrations exceed the criteria;

2. Monitoring of groundwater, consistent with the requirements of the CT RSRs volatilization criteria and to confirm in the future that no additional measures are required;
3. Installation of building ventilation (subslab depressurization) to prevent migration of VOC vapors into any existing buildings, and/or to control the level of VOCs in vapor beneath or in any existing buildings. Also vapor barriers (or possibly subslab depressurization) for new buildings; and
4. Five-year site reviews to evaluate the effectiveness and adequacy of the remedial measure.

3.2.2.2 Effectiveness – Alternative GW2 - Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Under Alternative GW2, exposure to VOCs in vapor resulting from volatilization from groundwater would be prevented through the use of ELURs on any parcel of land or portion thereof overlying areas where groundwater impacted by the Site exceeds the CT RSRs residential or commercial/industrial volatilization criteria. GW2 also allows for the use of building ventilation for existing buildings in areas covered by ELURs and where the CT RSRs commercial/industrial volatilization criteria are exceeded, consistent with the CT RSRs. Alternative GW2 would prevent exposure from VOCs in vapor beneath or in any existing buildings located in areas where the VOC concentrations in groundwater exceed the CT RSRs commercial/industrial volatilization criteria, by using building ventilation controls to either prevent migration of VOC vapors into, or control the level of VOCs in vapors beneath and in, any existing buildings. Vapor barriers would be used to prevent VOC migration into new buildings. As a result, this alternative does not reduce toxicity, mobility or volume through treatment and does not minimize residual risks nor does it reduce the time to achieve acceptable levels in the groundwater. It does however, afford long-term protection, comply with ARARs and has no unacceptable short term impacts. As a result, this alternative does provide adequate protection of human health and the environment.

3.2.2.3 Implementability – Alternative GW2 - Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Alternative GW2 is implementable because it involves the use of accepted institutional controls, groundwater monitoring, and an acceptable engineered control. Institutional controls are commonly used in Connecticut to address similar issues. Since groundwater monitoring is on going under the Long-Term Monitoring Plan, continuation of the appropriate level of monitoring is easily implemented.

Building ventilation or vapor barriers are standard construction options that could be easily implemented in an existing (or new) building located in areas where groundwater VOC concentrations exceed the CT RSRs volatilization criteria.

3.2.2.4 Cost – Alternative GW2 - Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Assuming a 30-year operational period and seven (7) percent interest, order of magnitude costs for Alternative GW2 could range from $200,000 to $700,000. Detailed cost estimates and sensitivity analysis are provided in the Section 4 Detailed Analysis.

3.2.3 **Alternative GW3 – Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers**

3.2.3.1 Description – Alternative GW3 – Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Under Alternative GW3, the following measures would be implemented:

1. Groundwater treatment would be provided through the construction of a PRB to intercept and treat shallow aquifer VOC contaminated groundwater leaving the Site;
2. Institutional controls in the form of ELURs on properties or portions of properties where groundwater VOC concentrations exceed the CT RSR volatilization criteria, to remain in place as long as groundwater VOC concentrations exceed the criteria;
3. Monitoring of groundwater, consistent with the requirements of the CT RSRs volatilization criteria and to confirm in the future that no additional measures are required;
4. Installation of building ventilation (subslab depressurization) and/or vapor barriers to prevent migration of VOC vapors into any existing or new buildings, and/or to control the level of VOCs in vapor beneath or in any new buildings; and
5. Five-year site reviews to evaluate the effectiveness and adequacy of the remedial measure.

3.2.3.2 Effectiveness – Alternative GW3 – Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Under Alternative GW3, exposure to VOCs in vapor resulting from volatilization from groundwater would be prevented in the long term through the installation of a permeable reactive barrier that would intercept and treat shallow VOC contaminated groundwater (within 30 ft of ground surface) leaving the Site. Although some uncertainty exits regarding the effectiveness of this alternative, groundwater VOC levels are expected to be reduced below respective CT RSR criteria for volatilization. Exposure to VOCs in vapor would also be prevented through the use of ELURs on any parcel of land or portion thereof overlying areas where groundwater impacted by the Site exceeds the CT RSRs volatilization criteria. GW3 allows for the use of building ventilation for existing buildings (or vapor barriers for new buildings) in areas where the CT RSRs volatilization criteria are exceeded, consistent with the CT RSRs. Alternative GW3 would prevent exposure from VOCs in any residual vapor beneath or in any existing buildings located in areas where the VOCs concentrations in groundwater exceed the CT RSRs volatilization criteria, by using building ventilation controls to either prevent migration of VOC vapors into, or control the level of VOCs in vapors beneath and in, any existing buildings. This alternative reduces toxicity, mobility or volume through treatment and minimizes residual risks and significantly reduces the time to achieve acceptable levels in the groundwater. It affords long-term protection and complies with ARARs. The alternative does have some short term impacts on the community due to construction along Old Turnpike Road. This alternative provides adequate protection of human health and the environment.

3.2.3.3 Implementability – Alternative GW3 – Permeable Reactive Barriers/Institutional Controls/ Groundwater Monitoring/Building Ventilation/Vapor Barriers

Alternative GW3 is implementable because it involves the use of accepted engineering methods, institutional controls, groundwater monitoring, and an acceptable engineered control. Permeable reactive barriers are an existing technology that has been successfully applied to the remediation of VOC contaminated sites similar to Old Southington. The presence of multiple utility lines along Old Turnpike Road and a soil berm adjacent to the road would present some implementability issues that would need to be addressed during PRB design. As previously noted, institutional controls are commonly used in Connecticut to address similar issues. Since groundwater monitoring is on going under the Long-Term Monitoring Plan, continuation of the appropriate level of monitoring is easily implemented.

Building ventilation or vapor barriers are standard construction options that could be easily implemented in an existing or new buildings located in areas where groundwater VOC concentrations exceed the CT RSRs volatilization criteria.

3.2.3.4 Cost – Alternative GW3 – Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Assuming a 30-year operational period and seven (7) percent interest, order of magnitude costs for Alternative GW3 could range from \$10,000,000-\$12,000,000. Detailed cost estimates and sensitivity analysis are provided in the Section 4 Detailed Analysis.

3.3 Summary – Development and Initial Screening of Alternatives

Three alternatives were developed to address groundwater within the Site and were evaluated with respect to their effectiveness, implementability, and cost. All alternatives are appropriate for further consideration and will be retained for detailed analysis. The three alternatives are:

- **Alternative GW1: No Action**
- **Alternative GW2: Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers**
- **Alternative GW3: Permeable Reactive Barrier/Institution Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers**

4.0 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

4.1 Introduction

The remedial alternatives for groundwater that were retained from Section 3 for detailed evaluation are the following:

- **Alternative GW1: No Action**
- **Alternative GW2: Institutional Controls/Groundwater Monitoring/Building Ventilation (Subslab Depressurization)/Vapor Barriers**
- **Alternative GW3: Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation (Subslab Depressurization)/Vapor Barriers**

The detailed analysis consists of an assessment of these individual alternatives against seven of nine criteria. Section 4.2 presents the nine evaluation criteria and the detailed evaluations of alternatives are presented in Section 4.3.

4.2 Evaluation Criteria

The detailed analysis of alternatives includes an assessment of each alternative's feasibility and overall effectiveness, based on the following nine criteria:

1. Overall protection of human health and the environment;
2. Compliance with ARARs;
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume;
5. Short-term effectiveness;
6. Implementability;
7. Cost;
8. State acceptance; and
9. Community acceptance.

Two of the criteria, community acceptance and state acceptance, are evaluated by EPA following selection of a preferred alternative and preparation of a proposed plan.

These nine criteria can be categorized into three groups, as follows:

- Threshold criteria, which include overall protection of human health and the environment, and compliance with ARARs. Unless a specific ARAR is waived, each alternative must meet these criteria in order to be eligible for selection;
- Primary balancing criteria, which include long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost; and
- Modifying criteria, which include state and community acceptance. These modifying criteria are evaluated following the public comment period.

Each of the criteria listed above is discussed in more detail below.

Overall Protection of Human Health and the Environment

Alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs (EPA, 1994).

Compliance with ARARs

The alternatives are assessed to determine whether they attain applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking a waiver pursuant to section 121(d)(4) of CERCLA and 40 CFR 300.430(f)(1)(ii)(C) (EPA, 1994).

Long-Term Effectiveness and Permanence

Alternatives are assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities; and
- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste (EPA, 1994).

Reduction of Toxicity, Mobility, or Volume Through Treatment

The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site. Factors include the following:

- The treatment or recycling processes the alternatives employ and materials they will treat;
- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;
- The degree of expected reduction in toxicity, mobility or volume of the waste due to treatment or recycling and the specification of which reduction(s) is occurring;
- The degree to which the treatment is irreversible;
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents; and
- Whether this alternative satisfies preference for treatment as a principal element.

Short-Term Effectiveness

The short-term impacts of alternatives are assessed as follows:

- Short-term risks that might be posed to the community during implementation of an alternative;

- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigating measures during implementation; and
- Time until remedial action objectives are achieved (EPA, 1994).

Implementability

The ease or difficulty of implementing the alternatives is assessed as follows:

- Ability to Construct and Operate the Technology;
- Reliability of the Technology;
- Ease of Undertaking Additional Remedial Actions, if necessary;
- Ability to Monitor Effectiveness of Remedy;
- Ability to Obtain Approvals From Other Agencies;
- Coordination with Other Agencies;
- Availability of Offsite Treatment, Storage, and Disposal Services and Capacity;
- Availability of Necessary Equipment and Specialists; and
- Availability of Prospective Technologies.

Cost Analysis

The types of costs that are assessed include the following:

- Capital costs, including both direct and indirect costs;
- Operation and maintenance costs (annual and non-annual); and
- Net present value of capital and O&M costs (EPA, 2000).

The basic procedures used to estimate the costs developed during the initial screening are used to prepare the detailed cost analyses. However, a greater level of accuracy is achieved at this stage. More extensive sources of information and more detailed preliminary design information are used during the detailed evaluation, so that the cost analyses developed for each alternative are accurate within -30 to +50 percent.

The accuracy of each cost estimate developed during the detailed evaluation depends upon the assumptions made with respect to the design, implementation, and operation of an alternative; it further depends on the cost information available. In order to assess the degree of certainty associated with the cost estimates for each alternative, and the impact of changes in underlying assumptions, a cost sensitivity analysis may be performed. The sensitivity analysis assesses assumptions associated with individual cost components and the effects they can have on the estimated cost for an alternative. The cost sensitivity analysis varies certain assumptions to determine potential effects on the cost of each alternative. The assumptions varied include factors, which possess the ability to cause significant change to total alternative costs with only small changes in values, and factors with a high degree of uncertainty associated with them. Low, medium and high case scenarios are developed for each alternative. A 30-year present worth cost is then prepared for the low, medium and high case scenarios of each alternative.

Appendix A provides detailed back up associated with each alternative's cost analyses. Present-worth costs are presented assuming a 30-year operational period, as appropriate, a seven (7) percent interest rate and a zero percent inflation rate.

State Acceptance

Assessment of state concerns may not be completed until comments on the RI/FS and proposed plan are received.

Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received (EPA, 1994).

4.3 Detailed Analysis of Groundwater Alternatives

The evaluations of groundwater alternatives discussed in this section address the degree to which the alternative would prevent the inhalation of VOCs in vapors resulting from the volatilization of VOCs from groundwater and comply with the CT RSRs volatilization criteria. For each alternative, a brief sentence, describing the criterion and highlighted with italics, is reiterated at the beginning of each evaluation to aid the reader and focus discussion for each criterion. Table 4-1 provides a summary of the detailed analysis of the groundwater alternatives.

4.3.1 **Alternative GW1: No Action**

4.3.1.1 Description – Alternative GW1 – No Action

The No Action alternative would not involve any type of work. No monitoring data would be generated, no institutional controls would be used to restrict land use, although Five-Year Site reviews would be completed. This alternative serves as a baseline for comparison to other alternatives.

4.3.1.2 Detailed Evaluation – Alternative GW1 – No Action

Overall Protection of Human Health and the Environment – Alternative GW1
This evaluation includes consideration of human health protection (with respect to the potential for inhalation of VOCs in vapors resulting from volatilization from groundwater) and environmental protection.

Under Alternative GW1, there would be no protection against VOCs volatilizing from shallow groundwater into existing buildings or future constructed buildings.

Under Alternative GW1, VOCs would remain in groundwater at concentrations exceeding the CT RSRs for vapor intrusion.

Compliance with ARARs – Alternative GW1
This evaluation considers whether the alternative will attain applicable or relevant and appropriate federal and State regulatory requirements or provide grounds for invoking a waiver.

Table 1-1 presents ARARs associated with Alternative GW1 for groundwater within the Study Area.

Table 4-1
Summary of Detailed Analysis of Remedial Alternatives

Assessment Factor	GW1: No Action	GW2: Institutional Controls/Groundwater Monitoring/Engineering Controls	GW3: Permeable Reactive Barrier Installed Downgradient of Site
Major Components	No remedial actions would be taken. Five –year site reviews.	Institutional controls, including CT ELURs to address exceedances of residential and commercial/industrial volatilization (vapor intrusion) criteria. Monitoring of VOCs in groundwater, consistent with the requirements of the CT RSRs volatilization criteria. Building ventilation, acceptable to CT DEP, to either prevent migration of VOC vapors into, or control the level of VOCs in vapor beneath or in, any existing buildings located in areas where VOC concentrations in groundwater exceed the CT RSRs vapor intrusion criteria. Installation of vapor barriers to prevent migration of VOC vapors into new buildings. Five-year site reviews.	Installation of a permeable reactive barrier (PRB) to treat VOC contaminated groundwater to meet CT RSRs for vapor intrusion. Institutional controls, including CT ELURs to address exceedances of vapor intrusion criteria. Monitoring of VOCs in groundwater, consistent with the requirements of the CT RSRs vapor intrusion criteria and federal requirements. Building ventilation, acceptable to CT DEP, to either prevent migration of VOC vapors into, or control the level of VOCs in vapor beneath or in, any existing buildings located in areas where VOC concentrations in groundwater exceed the CT RSRs vapor intrusion criteria. Installation of vapor barriers to prevent migration of VOC vapors into new buildings. Five-year site reviews.
Overall Protection of Human Health and the Environment	No protection against VOCs volatilizing from shallow groundwater into existing or future buildings. No adverse impacts to wetlands or surface waters. Study Area groundwater CT classification GB and groundwater use for drinking water is precluded. There is no exposure pathway for ingestion of groundwater used as drinking water.	ELURs address exceedances of vapor intrusion criteria, thereby preventing exposure to VOCs in vapors. Existing buildings would be protected by the use of building ventilation, consistent with CT RSRs. New buildings would be protected by vapor barriers. No adverse impacts to wetlands or surface waters. Study Area groundwater CT classification GB and groundwater use for drinking water is precluded. There is no exposure pathway for ingestion of groundwater used as drinking water.	Overall reduction in downgradient groundwater VOCs, due to treatment by PRB, to meet CT RSRs for vapor intrusion. ELURs also address exceedances of vapor intrusion criteria, thereby preventing exposure to VOCs in vapors. Existing buildings would be protected by the use of building ventilation, consistent with CT RSRs. New buildings would be protected by vapor barriers. No adverse impacts to wetlands or surface waters. Study Area groundwater CT classification GB and groundwater use for drinking water is precluded. There is no exposure pathway for ingestion of groundwater used as drinking water.
Compliance with ARARs	Would not meet Chemical-Specific ARARs for volatilization of VOCs from groundwater. Would meet Chemical-Specific ARARs for water quality. Would meet Action-Specific ARARs. No Location-Specific ARARs identified.	Would meet Chemical-Specific ARARs for volatilization of VOCs from groundwater, with building ventilation for existing buildings, and vapor barriers for new buildings. Would meet Chemical-Specific ARARs for water quality. Would meet Action-Specific ARARs. Would meet Location-Specific ARARs.	Would meet Chemical-Specific ARARs for volatilization of VOCs from groundwater, with building ventilation for existing buildings. Would meet Chemical-Specific ARARs for water quality. Would meet Action-Specific ARARs. Would meet Location-Specific ARARs.
Long-Term Effectiveness and Permanence	No protection against VOCs volatilizing from groundwater into existing or future buildings. No adverse impacts to wetlands or surface waters. Study Area groundwater CT classification GB and groundwater use for drinking water is precluded. There is no exposure pathway for ingestion of groundwater used as drinking water.	ELURs address exceedances of vapor intrusion criteria, thereby preventing exposure to VOC in vapors. Existing buildings would be protected by the use of building ventilation. New buildings would be protected by vapor barriers. No adverse impacts to wetlands or surface waters. Study Area groundwater CT classification GB and groundwater use for drinking water is precluded. There is no exposure pathway for ingestion of groundwater used as drinking water.	Residual risk in the long term is low as contaminated groundwater is permanently addressed through the use of PRBs. In the short term, residual risk is addressed through the use of institutional controls and engineering controls as described for Alternative GW2. These controls are adequate and reliable to the extent that they are monitored, maintained, and/or enforced.
Reduction of Toxicity, Mobility, or Volume	No reduction in TMV. No treatment residuals.	No reduction in TMV. Minor quantities of treatment residuals might be generated during building ventilation.	Overall reduction in toxicity, mobility and volume in downgradient groundwater VOCs, due to treatment by PRB to meet CT RSRs for vapor intrusion. Minor quantities of treatment residuals might be generated during building ventilation.
Short-Term Effectiveness	Would not impact the community or workers. The remedial response objectives would not be met.	Would not impact the community or workers. The remedial response objectives would be met within 6-12 months. .	Impact to surrounding community and local environment during PRB installation. Minimal impact to workers. The remedial response objectives would be met within 6-12 months. No impact to environments.
Implementability	Could be easily implemented and would not obstruct any additional remedial actions, if necessary.	Institutional controls would be readily implemented and readily enforceable. Building ventilation and vapor barriers would be readily implemented using standard, reliable techniques. Periodic monitoring of groundwater would be easily implemented. Would not obstruct any additional remedial actions, if necessary.	Technically and administratively implementable with projected PRB installation of moderate difficulty. The presence of utility lines and an elevated soil berm would generate certain challenges during design and construction. Building ventilation and vapor barriers would be readily implemented using standard, reliable techniques. Periodic monitoring of groundwater would be easily implemented. Would not obstruct any additional remedial actions, if necessary.
Cost (present worth)	$5,000 or more for each Five-Year Review.	$226,219 TO $695,240	$10.7M TO $12.5M

Alternative GW1 would not meet the Chemical-Specific ARARs for volatilization of VOCs from groundwater, since no remedial measures are being taken to control or prevent exposure to VOC in vapors.

Long-Term Effectiveness and Permanence – Alternative GW1

This evaluation considers the magnitude of residual risk and adequacy and reliability of controls. Under Alternative GW1, there would be no protection against VOCs volatilizing from shallow groundwater into existing buildings or future constructed buildings.

The magnitude of the residual risk remaining from untreated groundwater is high given that VOCs would remain in groundwater at concentrations exceeding volatilization criteria. Under this alternative there are no controls in place to address the untreated groundwater that remains in this portion of the Site.

Reduction of Toxicity, Mobility, and Volume through Treatment – Alternative GW1

This evaluation considers the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the type and quantity of residuals that will remain following treatment, and the degree of expected reduction in TMV

Because this alternative does not require any action to be taken, it does not use any treatment or recycling processes, does not reduce the amount of hazardous substances, and there is no reduction in toxicity, mobility or volume of the waste due to treatment. Because no treatment has been conducted under this alternative, this alternative does not satisfy the preference for treatment as a principal element. The type and quantity of residuals that will remain under this alternative does not change as no treatment has taken place to reduce residuals.

Short-Term Effectiveness – Alternative GW1

This evaluation considers protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until remedial response objectives are achieved.

Alternative GW1 would not impact the community workers or the environment since no active remedial actions are included in this alternative. The remedial response objectives would not be met under Alternative GW1.

Implementability – Alternative GW1

This evaluation considers the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, and the ease of undertaking additional remedial actions, if necessary.

Alternative GW1 would be technically feasible as there is nothing to construct, and therefore no issues regarding the reliability of the technology, ease of undertaking additional construction activities, or monitoring activities. There are no administrative feasibility issues regarding coordination nor are there any issues regarding availability of treatment, storage, equipment or specialists.

Cost – Alternative GW1

This evaluation includes capital costs, operation and maintenance costs and net present value of capital and O&M costs, assuming a 30-year operational period, as appropriate, a seven percent interest rate and a zero percent inflation rate.

There would be only minimal (five-year review) costs associated with the implementation of Alternative GW1, since no measures would be performed.

4.3.2 **Alternative GW2: Institutional Controls/Groundwater Monitoring/ Building Ventilation/Vapor Barriers**

4.3.2.1 Description – Alternative GW2 – Institutional Controls/Groundwater Monitoring/ Building Ventilation/Vapor Barriers

Under Alternative GW2, the following measures would be implemented:

- Institutional controls in the form of ELURs on properties or portions of properties where groundwater VOC concentrations exceed the CT RSR volatilization criteria, to remain in place as long as groundwater VOC concentrations exceed the criteria;
- ELURs would address VOC volatilization issues on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs residential or commercial/industrial volatilization criteria (also denoted as volatilization or vapor intrusion criteria);
- Monitoring of groundwater, consistent with the requirements of the CT RSRs volatilization criteria and to ensure the protectiveness of this alternative in the future;
- Existing buildings where the CT RSRs commercial/industrial volatilization criteria are exceeded, would require, consistent with the CT RSRs, ventilation to control VOCs in vapor beneath existing buildings; vapor barriers for new buildings; and
- Five-year site reviews to evaluate the effectiveness and adequacy of the remedial measure.

Institutional Controls

As defined by the CT RSRs, ELURs would be placed on the portions of properties where VOCs in groundwater exceed the RSR volatilization criteria. The ELURs would address VOC volatilization issues on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs residential or commercial/industrial volatilization criteria, as appropriate.

Building Ventilation/Vapor Barriers (Risk Mitigation Measures)

Building ventilation (subslab depressurization) would be implemented in existing buildings located over portions of properties where VOCs in groundwater exceed the CT RSRs commercial/industrial volatilization criteria. Building ventilation controls would be used to either prevent migration of VOC vapors into, or control the level of VOC in vapors beneath or in, any existing buildings. Similarly vapor barriers (or possibly subslab depressurization) would be used to control vapors in new buildings.

Monitoring

Monitoring for the groundwater remedy[1] must address the remedial objective set forth in this AFS. The remedial objective includes compliance with CT RSRs volatilization criteria. These criteria include specific requirements for monitoring to demonstrate compliance as well as post-remediation groundwater monitoring. In late fall 2005, an extensive shallow groundwater VOC sampling and analysis effort was completed on the properties immediately downgradient of the landfill to carefully define the extent of areas where either criteria

[1] A quarterly monitoring program is currently in place pursuant to the Statement of Work (SOW) for the SGI, the Operations & Maintenance Plan pursuant to the ROD for the Interim Remedial Action for Limited Source Control (CAP ROD), and subsequent discussions with and requests from EPA and CT DEP. That portion of the current monitoring program that addresses the Interim ROD is subject to review and modification under the Five-Year Review process for the Interim ROD. The monitoring program for Interim ROD addresses and will continue to address cap effectiveness and any other applicable solid waste landfill requirements.

is currently exceeded. Based on that sampling and analysis effort, areas where residential or commercial/industrial volatilization criteria may be exceeded have been delineated, and compliance wells will be installed at appropriate locations, to collect groundwater to further verify contaminant distribution and concentrations, in accordance with the monitoring requirements of the CT RSRs and to ensure the protectiveness of the remedy in the future. There currently is no residential property use in the areas of the Study Area where residential or commercial/industrial volatilization criteria are exceeded.

Five-Year Reviews

Five-Year Site reviews would be performed to confirm the effectiveness and adequacy of measures implemented under Alternative GW2.

4.3.2.2 Detailed Evaluation – Alternative GW2- Institutional Controls/Groundwater Monitoring/ Building Ventilation/Vapor Barriers

Overall Protection of Human Health and the Environment – Alternative GW2
This evaluation includes consideration of human health protection (with respect to the potential for inhalation of VOCs in vapors resulting from volatilization from groundwater) and environmental protection.

This alternative provides overall protection of human health and the environment by preventing exposure to VOCs in vapors resulting from volatilization of VOCs in groundwater through the use of ELURs and, where appropriate, building ventilation (or vapor barriers), in areas where groundwater VOC concentrations exceed the CT RSRs residential or commercial/industrial volatilization criteria.

In addition, all ARARS would be met under this alternative.

Compliance with ARARs – Alternative GW2
This evaluation considers whether the alternative will attain applicable or relevant and appropriate federal and State regulatory requirements or provide grounds for invoking a waiver.

Table 1-1 includes all ARARs associated with Alternative GW2 for groundwater within the Study Area. As discussed in Table 1-1, all ARARs would be met for this alternative.

This alternative would include development and implementation of operations and maintenance plans to insure these controls remain reliable in the future.

Reduction of Toxicity, Mobility, and Volume through Treatment – Alternative GW2
This evaluation considers the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the type and quantity of residuals that will remain following treatment, and the degree of expected reduction in TMV.

This alternative does not use any treatment or recycling processes (except to the extent that air emissions generated during building venting require treatment) and does not reduce the amount of hazardous substances. There is no reduction in toxicity, mobility or volume of the waste due to treatment. However, this alternative does reduce the mobility of the waste thru use of building ventilation. Because no (or very minimal) treatment has been conducted under this alternative, this alternative does not satisfy the preference for treatment as a principal element. The type and quantity of residuals that will remain under this alternative does not change as no treatment has taken place to reduce residuals.

Under Alternative GW2A, minor amounts of treatment residuals (such as from carbon filters) might be generated depending on the concentrations of VOC in the vapor removed during sub-slab ventilations and whether the vapor requires treatment.

Short-Term Effectiveness – Alternative GW2

This evaluation considers protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until remedial response objectives are achieved.

There would be very limited short-term impacts to the community, workers, or the environment during implementation of Alternative GW2, since no additional remedial measures beyond institutional controls, engineering controls, and groundwater monitoring would be performed. Under Alternative GW2, the remedial action objective would be achieved within six (6) to twelve (12) months. This time would allow for any necessary ELURs and building ventilation, as appropriate, to be put in place for areas where groundwater exceeds the CT RSRs commercial/industrial volatilization criteria.

Implementability – Alternative GW2

This evaluation considers the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, and the ease of undertaking additional remedial actions, if necessary.

The components of Alternative GW2, would be technically feasible as monitoring wells are currently in place and additional wells can easily be constructed. In addition, building ventilation and/or vapor barriers are standard, reliable technologies that can easily be put in place. As a result, there are no issues regarding the reliability of the technologies, ease of undertaking additional construction activities, or monitoring activities. There are few administrative feasibility issues regarding putting institutional controls in place. Finally, given the standard nature of all components of this alternative there are no issues regarding availability of treatment, storage, equipment or specialists.

Implementation of Alternative GW2 would not obstruct additional remedial actions, if required at a later time.

Cost – Alternative GW2

This evaluation includes capital costs, operation and maintenance costs and net present value of capital and O&M costs, assuming a 30-year operational period, as appropriate, a seven percent interest rate and a zero percent inflation rate.

The cost sensitivity analysis for Alternative GW2 considers the potential range of costs associated with any necessary ELURs and building ventilation, as appropriate. The cost calculation assumes that one or two buildings will require building ventilation at the onset of the remedial activities. The low cost assumes the ventilation of one existing building (1200 sq. ft.; 12,000 cu. ft.) using an exhaust fan to remove air from within the building. The medium and high costs assume a sub-slab ventilation system (as is preferred by CT DEP) is installed in one existing building of 1200 sq. ft. (medium cost) and two existing buildings of 1200 sq. ft. and 4000 sq. ft. (high cost).

Costs also assume a level of groundwater monitoring for VOCs that would be required by the CT RSRs volatilization criteria to demonstrate that the ELUR boundaries estimated to date are correct and then for additional monitoring in the future.

Low and medium costs assume a capital cost for installation of 10 SDW for compliance. The high cost, as discussed above, assumes that an additional five SDW are required in year four, following the three years of monitoring.

Appendix A (Tables A-1, A-2 and A-3) provide the detailed summary of the low, medium, and high costs, respectively, as summarized below. Backup tables used for calculating present worth costs for O&M are provided in Appendix B.

The development of costs for Alternative GW2 include the following:

Capital Costs

- Institutional controls: A fixed cost line item for all activities associated with obtaining the ELURs, based on prior experience. As mentioned above, the fixed cost is varied for the low, medium, and high cost estimates;
- Installation of 10 SDW compliance wells; and
- Installation of an air exhaust system (low cost) or a sub-slab ventilation system (medium and high costs) at one existing building (low and medium costs) or two existing buildings (high cost): Based on current data there may be one existing commercial building located over an area where the groundwater VOC concentrations exceed the CT RSRs residential or commercial/industrial volatilization criteria. A capital cost is included for the components, installation, and startup of the systems.

Operation & Maintenance Costs

- Quarterly groundwater monitoring: Costs are based on groundwater monitoring, as required by the CT RSRs and federal requirements. The frequency and number of wells will vary;
- Post-compliance groundwater monitoring: Costs are based on groundwater monitoring, as required by the CT RSRs and federal requirements. The frequency and number of wells will vary;
- Installation of 5 additional SDW, as discussed above, as a line item cost based on assumptions used for initial installation of SDW; occurs in year 4 in the high cost;
- O&M for the building ventilation of one (low and medium costs) or two (high cost) existing buildings: These costs assume O&M for 30 years and include a system replacement in year 15; and
- Five-year site reviews: For consistency in comparing costs between alternatives five-year site reviews are costed at $5000 each. [Note – Actual five-year review costs may significantly exceed this figure.]

Cost Case Scenario	Capital Cost	Present Worth O&M Cost	Total Present Worth Cost
GW2 - Low	$77,456	$148,763	$226,219
GW2- Medium	$192,814	$235,950	$428,764
GW2-High	$345,803	$349,438	$695,240

4.3.3 Alternative GW3 – Description – Alternative GW3 – Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

4.3.3.1 Description – Alternative GW3 – Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

Alternative GW3 includes the following remedial options:

- Treatment of contaminated groundwater with a PRB to reduce shallow downgradient groundwater VOC levels below CT RSRs commercial/industrial volatilization (vapor intrusion) criteria. The PRB will be located immediately downgradient of western portions of the OSL cap and adjacent to areas of groundwater RSR exceedences.

- Institutional controls in the form of ELURs on properties or portions of properties where groundwater VOC concentrations exceed the CT RSR vapor intrusion criteria.
- Long-term monitoring of groundwater, consistent with the requirements of EPA and the CT RSR volatilization criteria.
- Installation of building ventilation to prevent migration of VOC vapors into any existing buildings, or to control the level of VOC vapor beneath any existing building.
- Installation of foundation vapor barriers for any newly constructed buildings to prevent migration of VOC vapors into the buildings.
- Five-year reviews to evaluate the effectiveness and adequacy of the remedial measure.

The approach to site remediation under this Alternative includes groundwater remediation through the installation of a PRB downgradient of the source area. An area of elevated groundwater VOC concentrations in the shallow zone, based on down-gradient monitoring results, has been selected for placement of the PRB. Figure 4-1 shows approximate location, horizontal extent and conceptual design layout for installation of the PRB. Figure 4-2 provides a summary of the vertical groundwater profile in the area. Based on this information a 900 ft total length PRB was selected. Focusing on remediation of the shallow plume, a hanging gate design for the PRB would be used, as the PRB is not required to penetrate the entire thickness of the aquifer. At OSL, it has been determined that 20 to 30 ft depth into the groundwater table would be the most practical for treating the shallow aquifer, based on existing mean depths to groundwater and the 30-ft depth zones associated with groundwater RSRs.

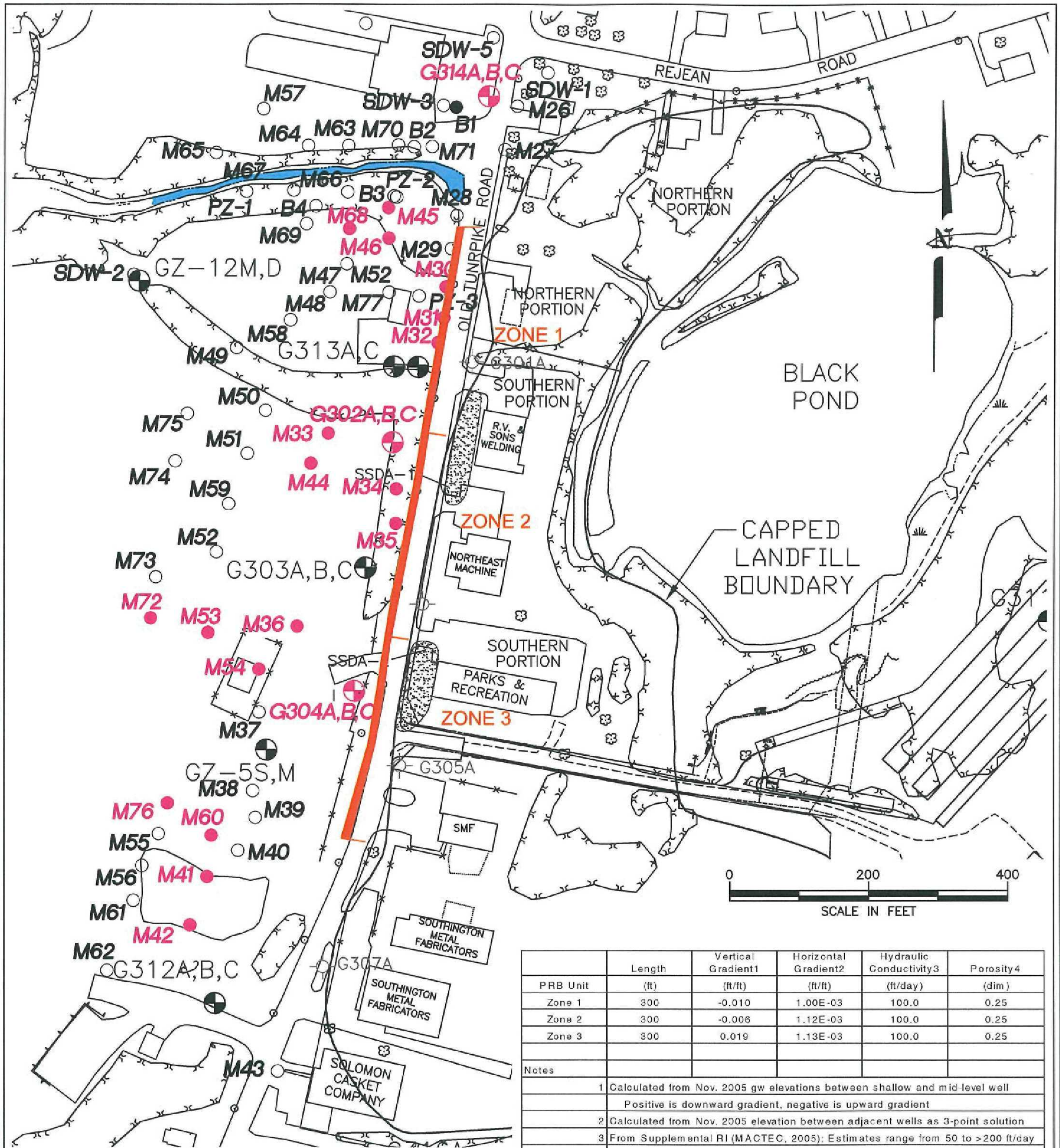
The reactive wall estimated at 900 ft in length would be constructed across the width of the groundwater plume in the specified area where the depth to groundwater is not greater than 30 ft below ground surface (bgs). Modification of or additional PRB length may be recommended following results of more detailed designs including groundwater modeling of the area.

The 900 ft PRB would be constructed in three specific zones of 300 ft each and comprised of zero-valent iron inserted throughout the saturated thickness. The contiguous PRB would be installed to approximately 30 ft below the mean groundwater elevation with a flow-through thickness of 2.6 ft in the first 300 ft section, approximately 20 ft below the mean groundwater elevation with a flow-through thickness of 1.3 ft in the second 300 ft section and approximately 20 ft below the mean groundwater elevation with a flow-through thickness of 3.3 ft in the third 300 ft section. The PRB design has been conceptualized based on existing groundwater data, resulting in a required mass of iron of approximately 4,000 tons for the complete PRB. The actual design parameters of the PRB system would have to be further detailed as part of the design process.

This remedial measure is anticipated to achieve RSRs for vapor intrusion in shallow groundwater emanating from the landfill and not rely upon institutional controls and risk mitigation measures alone for protection of human health and the environment over the long term.

In considering the site hydrogeology, it is acknowledged that some upgradient-contaminated groundwater presently in the shallow zone may underflow the PRBs. However, at the OSL Site, this would, in fact, likely have the desirable result of transference of shallow VOC contamination into the deeper plume. Achievement of RSRs for vapor intrusion is a primary remedial action objective for OSL. Any inadvertent downward migration of the VOC plume should substantively assist the PRB in reducing shallow groundwater VOC concentrations (and associated RSR concerns) downgradient of the site.

The institutional control, groundwater monitoring, building ventilation and vapor barrier components of this alternative would be as described for Alternative GW2.



PRB Unit	Length (ft)	Vertical Gradient1 (ft/ft)	Horizontal Gradient2 (ft/ft)	Hydraulic Conductivity3 (ft/day)	Porosity4 (dim)
Zone 1	300	-0.010	1.00E-03	100.0	0.25
Zone 2	300	-0.006	1.12E-03	100.0	0.25
Zone 3	300	0.019	1.13E-03	100.0	0.25

Notes
1 Calculated from Nov. 2005 gw elevations between shallow and mid-level well
Positive is downward gradient, negative is upward gradient
2 Calculated from Nov. 2005 elevation between adjacent wells as 3-point solution
3 From Supplemental RI (MACTEC, 2005); Estimates range from 50 to >200 ft/day
4 From Supplemental RI (MACTEC, 2005)

KEY:

- FALL 2005 LOCATIONS EXCEEDING INDUSTRIAL OR RESIDENTIAL RSRs
- PROPOSED PRB LOCATION
- UNNAMED STREAM

NOTE: BASEMAP ADAPTED FROM "FIGURE 1-1 AMENDED FEASIBILITY STUDY" (KLEIN FELDER, FEB 21, 2006)

FIGURE 4-1

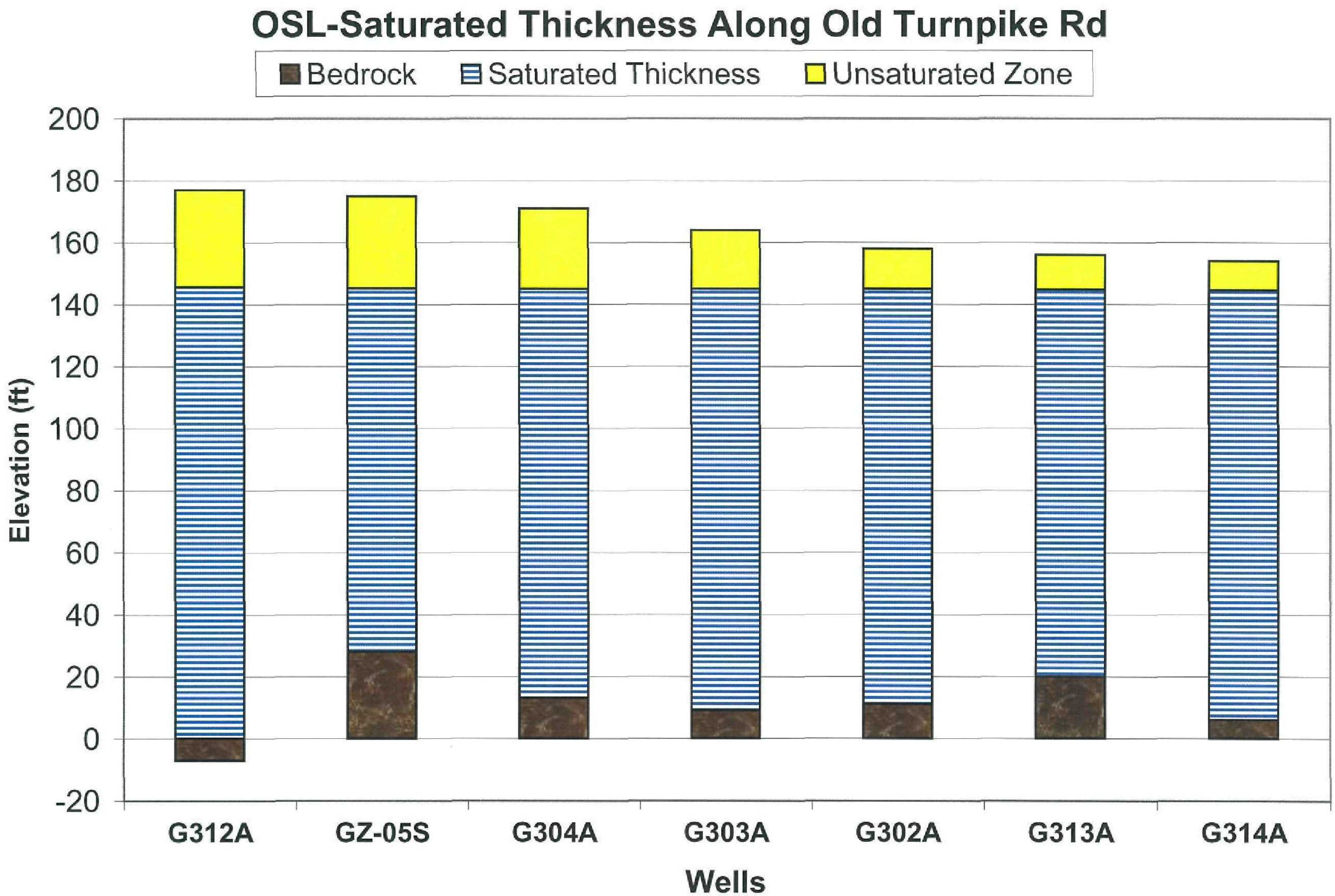
OLD SOUTHINGTON LANDFILL SUPERFUND SITE
SOUTHINGTON, CONNECTICUT

APPROXIMATE LOCATION FOR PERMEABLE REACTIVE BARRIER

TETRA TECH EC, INC.

CAD FILE: 1657.0022-A001 Rev A.DWG

FIGURE 4-2



Note: Groundwater elevations based on 11/30/05 measurements

4.3.3.2 Detailed Evaluation – Alternative GW3 – Permeable Reactive Barrier/Institutional Controls/Groundwater Monitoring/Building Ventilation/Vapor Barriers

The following discussion evaluates this Alternative with respect to the seven threshold and primary balancing FS criteria.

Overall Protection of Human Health and the Environment

This Alternative would protect human health and the environment at OSL through a combination of in-situ groundwater treatment, institutional controls, groundwater monitoring, building ventilation and vapor barriers. PRBs along the western landfill boundary would contain, treat and significantly reduce migration of shallow VOC contaminants from source area groundwater. It is anticipated that CTDEP RSRs for vapor intrusion for groundwater contaminants of concern would be achieved in the shallow aquifer. Institutional controls would also be employed to restrict use of groundwater that would result in adverse risk to human health. Risk mitigation measures (building ventilation and vapor barriers) would be implemented as necessary to treat indoor vapors in residences or businesses. Risks to workers and the public would be adequately controlled during implementation of risk mitigation measures, in-situ groundwater treatment activities and long-term monitoring through site-specific health and safety plans.

In regards to environmental protection, the installation of PRBs immediately downgradient of the northern portion of the landfill may also assist in minimizing any possible future migration of groundwater VOCs toward downgradient surface waters and sediments including the unnamed stream.

Compliance with ARARs

This Alternative is expected to meet all federal, state, and local ARARs including chemical-specific ARARs for groundwater over the longer term. Groundwater contaminant concentrations downgradient of source areas of OSL would be expected to achieve RSRs and regulatory limits over the longer term. The exact rate of reduction of VOCs in downgradient groundwater is uncertain. However, shallow groundwater VOC concentrations immediately downgradient of the PRBs would be expected to significantly improve, within a few years of completion of PRB construction. Contaminated groundwater collected during the construction of the PRBs and during the long-term monitoring program would be properly disposed of off-site. The PRBs will not have any discharge products, however vapor emissions from building ventilation systems may contain elevated total VOC concentrations that will be treated as necessary with carbon absorption units to reduce the total VOC emissions to comply with air quality regulations. The spent carbon units may be recycled or regenerated by the manufacturer, or managed and disposed of in accordance with state and federal solid and hazardous waste disposal regulations.

Long-Term Effectiveness and Permanence

The use of a PRB is anticipated to reduce the concentrations of VOCs in the shallow groundwater flowing through the PRB to levels below RSRs criteria for vapor intrusion. Continued maintenance of the PRB would be required until RSRs are met in shallow groundwater throughout the OSL source area. Institutional controls and risk mitigation measures would also ensure adequate protection of human health if properly implemented and maintained. However, they rely upon continuous management to maintain their effectiveness.

Reduction of Toxicity, Mobility, or Volume of Contaminants Through Treatment

Institutional controls and risk mitigation measures provide no reduction in the toxicity, mobility or volume of contaminants. This Alternative uses a PRB to destroy contaminants in shallow groundwater downgradient of the OSL source area and to reduce concentrations to below CT RSRs criteria for vapor intrusion. This alternative reduces the toxicity, mobility, and volume of groundwater VOC contamination through treatment.

After RSRs were met in portions of groundwater, monitoring would provide confirmation of continuing slow reductions in the toxicity and volume of contaminants in groundwater.

Short-Term Effectiveness

Exposure of remediation workers, the surrounding community and the local environment to contaminants would be minimal during implementation of PRB installation, institutional controls, monitoring and building ventilation/vapor barriers. No difficulties are foreseen with managing the small quantities of contaminated soil, water, and vapor produced during PRB construction and operations and during long-term monitoring. Any exposed soil or encountered groundwater would be transported off-site and disposed of in accordance with the State of CT solid and hazardous waste disposal regulations.

The excavation necessary to install the permeable reactive barrier may briefly expose soil and groundwater containing VOCs. Controls would be implemented to protect remediation workers and to prevent excess exposure to contaminated soil during its removal, transport, treatment, and disposal. The use of continuous trenching and backfilling will eliminate the need for dewatering, and will reduce the amount of water from the plume being brought to the surface. Since the final PRB system is below ground and requires little maintenance, remediation workers may be exposed to groundwater only when sampling. Some short term impacts to the community may occur from disruption on Old Turnpike Road due to construction activities and truck traffic.

For the building ventilation mitigation measure, VOC vapor emissions would be treated to acceptable levels using carbon adsorption units. The spent carbon units may be recycled or regenerated by the manufacturer or managed and disposed of based on solid and hazardous waste requirements.

The time to achieve RSRs in shallow groundwater is uncertain at this time. However it could be estimated using established modeling scenarios. In groundwater migrating through the PRB, VOC concentrations will be reduced below the respective RSR criteria for vapor intrusion.

Implementability

This Alternative is technically and administratively implementable at OSL, although some significant issues exist as to implementability.

Institutional controls have been implemented at other, similar sites, and are commonly widely used. Federal, state, and local agencies have administrative authority to implement institutional controls.

Equipment, materials, and services necessary for building ventilation/vapor barrier measures in regards to vapor intrusion at any existing or newly constructed buildings are available.

PRBs have been successfully installed and maintained at other, similar sites. Several vendors specialize in continuous trenching and production of zero-valent iron for PRB installation. Continuous trenching techniques are commonly used for installation of PRBs and other systems, such as drainage trenches and pipe installation. PRB construction at the suggested areas is expected to be of moderate difficulty due to the length and depth of the trench. PRB construction is not expected to have significant short-term impacts to the activities at the surrounding properties because the location of the barrier is away from active work areas. Additional design tests and modeling would be necessary to determine optimal PRB placement and design.

Ideally, a PRB would be installed along the edge of the landfill or the edge of Old Turnpike Road. However, the existence of the landfill cap, gas service, sewer service, water service and a storm drain running in parallel starting at the edge of the landfill, along Old Turnpike Road, and on the west side of Old Turnpike Road, leave little room for installation of a PRB without significant utility relocation. On the west side of Old Turnpike

Road, construction would be impeded by the presence of overhead electric lines. Therefore, the installation of a PRB would probably have to be west of the electric lines and, for a significant portion of a north-south running trench, atop a soil berm of moderate height above grade, requiring regrading of the bermed area. This may present some implementability challenges during construction. The optimal location for the PRB would need to be determined during design studies.

Cost

The total present worth cost range for implementing the complete Alternative GW3 at OSL is $10.7-12.5M including design and a 20% contingency ($10.4-11.8M for the PRB and $0.3-0.7M for the Institutional Controls, Building Mitigation Measures, and Long-Term Monitoring).

5.0 COMPARATIVE ANALYSIS

This section presents the comparative analysis of the potential remedial alternatives. The comparison is based on the seven criteria presented in Section 4 and summarized on Table 4-1.

Overall Protection of Human Health and the Environment
This evaluation includes consideration of human health protection (with respect to the potential for inhalation of VOC in vapors resulting from volatilization from groundwater) and environmental protection.

Except for the No Action Alternative (GW1), the alternatives provide for protection against exposure to VOCs volatilizing from shallow groundwater. Alternative GW2, through the use of ELURs, relies on institutional controls to protect against exposure to VOCs volatilizing from shallow groundwater on any parcel of land or portion thereof overlying areas where groundwater exceeds the CT RSRs residential or commercial/industrial volatilization criteria. Where there are existing buildings over areas where groundwater exceeds the CT RSRs commercial/industrial volatilization criteria, building ventilation (subslab depressurization), consistent with the CT RSRs, provides protection by preventing migration of VOC vapors into, or controlling the level of VOCs in vapor beneath or in, any existing buildings. For new buildings vapor barriers will provide protection from VOC vapors.

Overall protection under Alternative GW-3 is provided by a combination of shallow groundwater treatment and the same institutional controls/engineering controls identified above for GW2. This protection is achieved through reduction of contaminant concentrations in groundwater to meet CT RSRs criteria for vapor intrusion and limiting exposure to any residual contaminants through ELURs, building ventilation and vapor barriers. Groundwater protection is improved under Alternative GW-3 compared to Alternative GW-2 because contaminated groundwater is being treated.

Compliance with ARARs
This evaluation considers whether the alternative will attain applicable or relevant and appropriate federal and State regulatory requirements or provide grounds for invoking a waiver.

Alternatives GW2 and GW3 would meet all Chemical-Specific ARARs for water quality, Action-Specific ARARs, and any identified Location-Specific ARARs. Alternative GW1 would not meet Chemical-Specific ARARs for volatilization of VOCs from shallow groundwater.

Long-Term Effectiveness and Permanence
This evaluation considers the magnitude of residual risk and adequacy and reliability of controls.

The residual risk under alternatives GW1 and GW2 is high as the source of the vapor intrusion (contaminated groundwater) is not addressed. The residual risk under GW3 is low as contaminated groundwater is addressed although the effectiveness of this alternative is somewhat uncertain as well as the time it takes to achieve the cleanup levels.

Alternatives GW2 and GW3 provide for protection against exposure to VOCs volatilizing from shallow groundwater through institutional and engineering controls. These controls are reliable as long as they are properly implemented and maintained. Alternatives GW2 and GW3 rely on institutional and engineered controls to protect against exposure to VOC volatilizing from shallow groundwater on any parcel of land or portion thereof overlying areas where groundwater impacted by the Study Site exceeds the CT RSRs vapor intrusion criteria. Where there are existing buildings over areas where groundwater exceeds the CT RSRs vapor intrusion criteria, building ventilation (or vapor barriers), consistent with the CT RSRs, provides protection by preventing migration of VOC vapors into, or controlling the level of VOC in vapor beneath or in, any existing or new buildings.

Reduction of Toxicity, Mobility, and Volume through Treatment

This evaluation considers the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the type and quantity of residuals that will remain following treatment, and the degree of expected reduction in TMV.

Neither Alternatives GW1 nor GW2 result in a reduction of TMV through treatment. Alternative GW1 does not result in the generation of treatment residuals. Limited quantities of treatment residuals (such as spent carbon) may result from building ventilation if treatment of vented vapors is required due to the concentration of VOC in the vapors.

Alternative GW-3 reduces the toxicity, mobility, and volume of contaminants through treatment of contaminated groundwater. Under this alternative shallow contaminated groundwater passing through the PRB would be treated. This alternative destroys and removes the contaminants from the shallow groundwater migrating downgradient from the landfill.

Short-Term Effectiveness

This evaluation considers protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until remedial response objectives are achieved.

Neither Alternative GW1 nor Alternative GW2 would significantly impact the community, workers, or the environment. Alternative GW1 would not meet the remedial response objectives. Alternative GW2 would meet the remedial response objectives, using building ventilation for existing buildings located in areas where the VOC concentrations in groundwater exceed the CT RSRs vapor intrusion criteria. Alternative GW2 would meet remedial response objectives within six to twelve months. This time period would be required to obtain the necessary ELURs and implement building ventilation, if necessary.

Alternative GW-3 has installed treatment components that may create relatively minor visual and auditory nuisances. The potential for remediation workers to have direct contact with contaminants in soil or groundwater occurs during installation, maintenance and monitoring operations. Excavation activities under Alternative GW-3 would require significant disruption to the impacted surface soils along a major roadway and to the community. Environmental drilling to install monitoring wells and/or extraction and injection wells would occur under Alternative GW-3. Environmental drilling and excavation may produce contaminated soil cuttings and liquids that present some risk to remediation workers at the site. Groundwater monitoring will have minimal impact on workers responsible for periodic sampling. No off-site water discharges occur under GW3.

Implementability

This evaluation considers the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, and the ease of undertaking additional remedial actions, if necessary.

Alternatives GW1 and GW2 could be easily implemented and would not obstruct any additional remedial actions, if necessary.

Institutional controls would be readily implementable and enforceable. Groundwater monitoring would be easily implementable and qualified personnel and equipment is readily available. Building ventilation and vapor barriers would be easily implemented using standard, reliable techniques.

Permeable reactive barriers under Alternative GW-3 would be moderately difficult to construct at OSL because of the varied surface terrain and the extensive length and depth of trenching required. This alternative would also likely require placement of the PRB on private property immediately downgradient of the landfill as well as significant disruption on Old Turnpike Road, a major road in the community. However, PRBs have been successfully installed at other similar sites and expected construction difficulties are not considered insurmountable. PRBs are expected to be easy to operate since there is no active operating equipment, no power requirements, no special techniques or facility relocation required and no water or air discharges. PRB treatments are considered a moderately reliable technology. However, site-specific pilot or design studies are considered necessary in order to maximize effectiveness.

Cost

This evaluation includes capital costs, operation and maintenance costs and net present value of capital and O&M costs, assuming a 30-year operational period, as appropriate, a seven percent interest rate and a zero percent inflation rate.

There would be relatively minor costs associated with Alternative GW1, as no remedial measures would be implemented. Alternative GW1 would, however require the performance of Five Year Reviews estimated at $5,000 (or more) every five years over 30 years. The present worth cost range for Alternative GW2 is $226,219 to $695,240. The present worth cost range for Alternative GW3 is $10.7M - 12.5M.

6.0 REFERENCES

Baes, C.F., and R.D. Sharp, 1983. A proposal for estimation of soil leaching and leaching constants for use in assessment models. Journal of Environmental Quality 12, 17-28.

Battelle Pacific Northwest Laboratories. 1984. Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration, Volume 1: A Critical Review: Electric Power Research Institute Report EA-3356.

Bear, J., 1979. Hydraulics of Groundwater. McGraw-Hill Book Company, New York, NY.

Chow, 1964. Handbook of Applied Hydrology. McGraw-Hill Book Company, New York, NY.

EPA, 1994. National Contingency Plan, 40 CFR 300, as revised September 15, 1994.

EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002, July 2000.

ESE, 1993. Remedial Investigation/Feasibility Study Old Southington Landfill Superfund Project, Southington, Connecticut, Project 4925534. Environmental Science & Engineering, Inc. Final: December 10, 1993.

Harding ESE, 2001. Final Phase 2A Report – Old Southington Landfill Superfund Site. Harding ESE, Inc. April 27, 2001.

LaSala, A.M., R.L. Meikle, 1964. Connecticut Water Resources Bulletin No. 5.

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt, 1982. Handbook of Chemical Property Estimation Methods. New York: McGraw-Hill.

MACTEC, 2005. Supplemental Remedial Investigation Report, Old Southington Landfill Superfund Site. MACTEC Engineering and Consulting, Inc., February 4, 2005.

Mazzaferro, David L., 1973. Hydrogeologic Data For the Quinnipiac River Basin, Connecticut, Connecticut Water Resources Bulletin No. 26.

Mazzaferro, David L., 1975. Contour Map of the Bedrock Surface, Southington Quadrangle, Connecticut, USGS Map MF-660 A.

Mazzafero, D.L., Handman, E.H., and Thomas, M.P., 1979. Water Resources Inventory of Connecticut, Part 8, Quinnipiac River Basin: Connecticut Water Resources Bulletin No. 27, Connecticut Geological and Natural History Survey.

Walton, W.C., 1985, Practical aspects of groundwater modeling: Worthington, Ohio, National Water Well Association.

Warzyn Engineering, Inc., 1980. Hydrogeologic Investigation, Town of Southington, Connecticut.

APPENDIX A

DETAILED COST TABLES

TABLE A-1
ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

CAPITAL COST

Item	Component Description	Quantity	Units	Unit Cost	Item	Ref.
No.				$/unit	Cost	
1	Institutional controls/ELURS	1	ls	$25,000	$25,000	P
2	Installation of SDW compliance wells	10	ls	$18,000	$18,000	P
	Ventilation System Components					
3	EN404 Rotron Blower (1HP, single-phase)	1	ea	$1,150	$1,150	V
4	Miscellaneous Supplies	1	ea	$250	$250	V
5	Ventilation System Installation & Ducts	1	ea	$1,500	$1,500	V
	SUBTOTAL CONSTRUCTION:				**$45,900**	
	CONSTRUCTION CONTINGENCIES AND ADMIN.:	25%			**$11,475**	
	HEALTH AND SAFETY CONTROLS %:	10%			**$4,590**	
	TOTAL CONSTRUCTION:				**$61,965**	
	ENGIN. DESIGN AND CONSTR. SUPERV.:	25%			**$15,491**	
	TOTAL CAPITAL COST:				**$77,456**	

Capital Costs Notes:
3. - 5.) Assumes ventilation system on 1 existing building.
11.) Assumes 3-field days.

OPERATION AND MAINTENANCE COST

Item	Component Description	Quantity	Units	Unit Cost	Item	Ref.
No.				$/unit	Cost	
1	Quarterly Compliance Monitoring - 1st year	4	Yr1	$7,000	$26,170	V,P
2	Post-Compliance Monitoring (semi-annual)	2	Yr 2,3	$7,000	$23,660	P
3	Five-year site review	6	5yrs	$5,000	$10,790	P
	Exisitng Building Ventilation System					
4	Utilities	1	yr	$2,500	$36,020	P,V
5	Ventilation System O&M Labor (0.5 hrs per month)	6	yr	$45	$3,350	P
6	Ventilation System Equipment Repair	1	yr	$100	$1,240	P
7	Ventilation System System Replacement	1	yr15	$1,900	$690	P
8	Semi-annual Indoor Air Monitoring	2	yr1,2,3,4,5	$2,000	$17,090	P
	SUBTOTAL OPERATION AND MAINTENANCE COST:				**$119,010**	
	O&M CONTINGENCIES (as a percent of the total present value)	15%			**$17,852**	
	HEALTH AND SAFETY CONTROL	10%			**$11,901**	
	TOTAL O&M COST :				**$148,763**	
	TOTAL ALT COST:				**$226,219**	

O&M Notes:
4. - 8.) Assumes ventilation system on 1 existing building.
General Notes:
1.) Contingency percentages for capital costs were estimated from the Society of Cost Engineers model and site specific information.
2.) O&M item costs are Present Worth values based on a 7% interest rate.
3.) The total project cost is rounded off to the nearest $100.
4.) M= Means 1996, V= Vendor quote, P= previous project experience, E= Estimated value

TABLE A-2
ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

CAPITAL COST

Item No.	Component Description	Quantity	Units	Unit Cost $/unit	Item Cost	Ref.
1	Institutional controls/ELURS	1	ls	$50,000	$50,000	P
2	Installation of SDW compliance wells	10	ls	$18,000	$18,000	P
	Ventilation System Components					
3	EN505 Rotron Blower (2HP, single-phase)	1	ea	$1,450	$1,450	V
4	Moisture Seperator (MS200PS)	1	ea	$760	$760	V
5	Associated System Instrumentation	1	ea	$500	$500	V
6	Miscellaneous Manifold and Equipment Supplies	1	ea	$250	$250	V
7	Ventilation System Installation Service	1	ea	$4,000	$4,000	V
8	Shed Building	1	ea	$5,000	$5,000	V
9	Control Panel	1	ea	$3,500	$3,500	V
10	Vapor Phase Carbon (2-100 lb vessels)	1	ea	$2,000	$2,000	V
11	Electrilcal Service Installation and Start-up	1	ea	$10,000	$10,000	V
12	System Start-up	1	ea	$5,000	$5,000	P
	Sub-Slab Ventilation Components					
13	1/2" Crushed Stone	1,200	ft^2	$2.15	$2,580	V
14	4', Sch. 40, 0.010" slot PVC Screen	1,200	ft^2	$0.25	$300	V
15	4" Sch. 40 PVC Casing	1,200	ft^2	$0.15	$180	V
16	Installation Including Geotextile Fabric	1,200	ft^2	$0.95	$1,140	V
17	Directional Drilling	80	LF	$120.00	$9,600	V
	SUBTOTAL CONSTRUCTION:				**$114,260**	
	CONSTRUCTION CONTINGENCIES AND ADMIN.:	25%			**$28,565**	
	HEALTH AND SAFETY CONTROLS %:	10%			**$11,426**	
	TOTAL CONSTRUCTION:				**$154,251**	
	ENGIN. DESIGN AND CONSTR. SUPERV.:	25%			**$38,563**	
	TOTAL CAPITAL COST:				**$192,814**	

Capital Costs Notes:
3. - 17.) Assumes ventilation system on 1 existing building.
12.) Assumes 3-field days.

OPERATION AND MAINTENANCE COST

Item No.	Component Description	Quantity	Units	Unit Cost $/unit	Item Cost	Ref.
1	Quarterly Compliance Monitoring - 1st year	4	Yr1	$7,000	$26,170	V,P
2	Post-Compliance Monitoring (quarterly)	4	Yr 2,3,4,5	$7,000	$88,640	P
3	Five-year site review	6	5yrs	$5,000	$10,790	P
	Exisitng Building Ventilation System					
4	Utilities	1	yr	$3,000	$37,230	P,V
5	Ventilation System O&M Labor (2 hrs per month)	24	yr	$45	$13,400	P
6	Ventilation System Equipment Repair	1	yr	$500	$6,200	P
7	Ventilation System System Replacement	1	yr15	$17,460	$6,330	P
	SUBTOTAL OPERATION AND MAINTENANCE COST:				**$188,760**	
	O&M CONTINGENCIES (as a percent of the total present value)	15%			**$28,314**	
	HEALTH AND SAFETY CONTROL	10%			**$18,876**	
	TOTAL O&M COST :				**$235,950**	
	TOTAL ALT COST:				**$428,764**	

O&M Notes:
4. - 7.) Assumes ventilation system on 1 existing building.

General Notes:
1.) Contingency percentages for capital costs were estimated from the Society of Cost Engineers model and site specific information.
2.) O&M item costs are Present Worth values based on a 7% interest rate.
3.) The total project cost is rounded off to the nearest $100.
4.) M= Means 1996, V= Vendor quote, P= previous project experience, E= Estimated value

TABLE A-3
ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

CAPITAL COST

Item No.	Component Description	Quantity	Units	Unit Cost $/unit	Item Cost	Ref.
1	Institutional controls/ELURS	1	ls	$75,000	$75,000	P
2	Installation of SDW compliance wells	10	ls	$18,000	$18,000	P
	Ventilation System Components					
3	EN505 Rotron Blower (2HP, single-phase)	2	ea	$1,450	$2,900	V
4	Moisture Seperator (MS200PS)	2	ea	$760	$1,520	V
5	Associated System Instrumentation	2	ea	$500	$1,000	V
6	Miscellaneous Manifold and Equipment Supplies	2	ea	$250	$500	V
7	Ventilation System Installation Service	2	ea	$4,000	$8,000	V
8	Shed Building	2	ea	$5,000	$10,000	V
9	Control Panel	2	ea	$3,500	$7,000	V
10	Vapor Phase Carbon (2-100 lb vessels)	2	ea	$2,000	$4,000	V
11	Electrilcal Service Installation and Start-up	2	ea	$10,000	$20,000	V
12	System Start-up	2	ea	$5,000	$10,000	P
	Sub-Slab Ventilation Components					
13	1/2" Crushed Stone	5,200	ft^2	$2.15	$11,180	V
14	4', Sch. 40, 0.010" slot PVC Screen	5,200	ft^2	$0.25	$1,300	V
15	4" Sch. 40 PVC Casing	5,200	ft^2	$0.15	$780	V
16	Installation Including Geotextile Fabric	5,200	ft^2	$0.95	$4,940	V
17	Directional Drilling	240	LF	$120.00	$28,800	V
	SUBTOTAL CONSTRUCTION:				**$204,920**	
	CONSTRUCTION CONTINGENCIES AND ADMIN.:	25%			**$51,230**	
	HEALTH AND SAFETY CONTROLS %:	10%			**$20,492**	
	TOTAL CONSTRUCTION:				**$276,642**	
	ENGIN. DESIGN AND CONSTR. SUPERV.:	25%			**$69,161**	
	TOTAL CAPITAL COST:				**$345,803**	

Capital Costs Notes:
3. - 17.) Assumes ventilation system on 2 existing buildings.
12.) Assumes 3-field days.

OPERATION AND MAINTENANCE COST

Item No.	Component Description	Quantity	Units	Unit Cost $/unit	Item Cost	Ref.
1	Quarterly Compliance Monitoring - 1st year	4	Yr1	$7,000	$26,170	V,P
2	Post-Compliance Monitoring (quarterly)	4	Yr 2,3,4,5,6	$7,000	$107,290	P
3	Five-year site review	6	5yrs	$5,000	$10,790	P
4	Installation of 5 SDW	5	Yr4	$11,000	$8,980	P
	Exisitng Building Ventilation System					
5	Utilities	2	yr	$3,000	$74,450	P,V
6	Ventilation System O&M Labor (2 hrs per month)	48	yr	$45	$26,800	P
7	Ventilation System Equipment Repair	2	yr	$500	$12,410	P
8	Ventilation System System Replacement	2	yr15	$17,460	$12,660	P
	SUBTOTAL OPERATION AND MAINTENANCE COST:				**$279,550**	
	O&M CONTINGENCIES (as a percent of the total present value)	15%			**$41,933**	
	HEALTH AND SAFETY CONTROL	10%			**$27,955**	
	TOTAL O&M COST :				**$349,438**	
	TOTAL ALT COST:				**$695,240**	

O&M Notes:
5. - 8.) Assumes ventilation system on 2 existing buildings.

General Notes:
1.) Contingency percentages for capital costs were estimated from the Society of Cost Engineers model and site specific information.
2.) O&M item costs are Present Worth values based on a 7% interest rate.
3.) The total project cost is rounded off to the nearest $100.
4.) M= Means 1996, V= Vendor quote, P= previous project experience, E= Estimated value

TABLE A-4
OSL ORDER OF MAGNITUDE ESTIMATE – LOW COST
PERMEABLE REACTIVE BARRIER INSTALLATION

ITEM #	DESCRIPTION	UNIT	QTY.	UNIT PRICE	EXTENDED PRICE
1. PRE-INSTALLATION					
1a.	Bench Scale Test	ea.	1	$25,000.00	$25,000
1b.	Hydro Modeling	ea.	1	$50,000.00	$50,000
2. EARTHWORK					
2a.	Mobilization/Demobilization	ea.	1	$90,000.00	$90,000
2b.	Site Clearing	sq foot	27,000	$0.45	$12,150
2c.	Site Prep (earthwork/grading)	cubic yard	18,000	$4.30	$77,400
3. INSTALLATION					
3a.	Iron media, delivered	ton	4,000	$750.00	$3,000,000
3b.	PRB Construction	lump sum	1	$1,935,000.00	$1,935,000
3c.	Subcontractor design/licensing	lump sum	1	$760,000.00	$760,000
3d.	Monitoring well installation	ea.	34	$4,000.00	$136,000
3e.	PVC piping	lin ft.	1,000	$20.00	$20,000
3f.	Site Restoration	lump sum	1	$25,000.00	$25,000
3g.	Closeout/Reporting	lump sum	1	$50,000.00	$50,000
4. LANDSCAPING					
4.	Loam and seed	square yard	3400	$1.30	$4,420
5. DISPOSAL OF EXCAVATED SOILS – NON-HAZARDOUS (20%)		Ton	600	$48.00	$28,800
6. DISPOSAL OF EXCAVATED SOILS - HAZARDOUS (80%)		Ton	2400	$195.00	$468,000
	PRB CONSTRUCTION SUBTOTAL:				$6,681,770
7. FIELD OFFICE					
7a.	Field Office, Misc	allowance	5%	$6,681,770.00	$334,089
7b.	Construction Engineering Services	allowance	10%	$6,681,770.00	$668,177
7c.	Health and Safety	allowance	10%	$6,681,770.00	$668,177
	PRB CONSTRUCTION TOTAL:				$8,352,213
8. O&M					
8a.	Groundwater Monitoring *(quarterly Yr 1&2, semi-annually Yr 3, annually Yr 4-30)	present worth	*	$25,000.00	$466,225
8b.	Media Replacement (once – Yr 15)	present worth	1	$4,500,000.00	$1,629,000
				PRB O&M TOTAL:	$2,095,225
				PRB TOTAL:	$10,447,438
				LOW COST FROM GW2:	$226,219
				LOW COST GW3 TOTAL:	$10,673,657

TABLE A-5
OSL ORDER OF MAGNITUDE ESTIMATE – MEDIUM COST
PERMEABLE REACTIVE BARRIER INSTALLATION

ITEM #	DESCRIPTION	UNIT	QTY.	UNIT PRICE	EXTENDED PRICE
1. PRE-INSTALLATION					
1a.	Bench Scale Test	ea.	1	$25,000.00	$25,000
1b.	Hydro Modeling	ea.	1	$50,000.00	$50,000
2. EARTHWORK					
2a.	Mobilization/Demobilization	ea.	1	$90,000.00	$90,000
2b.	Site Clearing	sq foot	27,000	$0.45	$12,150
2c.	Site Prep (earthwork/grading)	cubic yard	18,000	$4.30	$77,400
3. INSTALLATION					
3a.	Iron media, delivered	ton	4,000	$750.00	$3,000,000
3b.	PRB Construction	lump sum	1	$1,935,000.00	$1,935,000
3c.	Subcontractor design/licensing	lump sum	1	$760,000.00	$760,000
3d.	Monitoring well installation	ea.	34	$4,000.00	$136,000
3e.	PVC piping	lin ft.	1,000	$20.00	$20,000
3f.	Site Restoration	lump sum	1	$25,000.00	$25,000
3g.	Closeout/Reporting	lump sum	1	$50,000.00	$50,000
4. LANDSCAPING					
4.	Loam and Seed	square yard	3400	$1.30	$4,420
5. DISPOSAL OF EXCAVATED SOILS – NON-HAZARDOUS (20%)		ton	600	$48.00	$28,800
6. DISPOSAL OF EXCAVATED SOILS - HAZARDOUS (80%)		ton	2400	$195.00	$468,000
	PRB CONSTRUCTION SUBTOTAL:				$6,681,770
7. FIELD OFFICE					
7a.	Field Office, Misc	allowance	10%	$6,681,770.00	$668,177
7b.	Construction Engineering Services	allowance	15%	$6,681,770.00	$1,002,266
7c.	Health and Safety	allowance	10%	$6,681,770.00	$668,177
	PRB CONSTRUCTION SUBTOTAL:				$9,020,390
8. O&M					
8a.	Groundwater Monitoring *(quarterly Yr 1&2, semi-annually Yr 3, annually Yr 4-30)	present worth	*	$25,000.00	$466.225
8b.	Media Replacement (once – Yr 15)	present worth	1	$4,500,000.00	$1,629,000
				PRB O&M TOTAL:	$2,095,225
				PRB TOTAL:	$11,115,615
				MEDIUM COST FROM GW2:	$428,764
				MEDIUM COST GW3 TOTAL:	$11,544,379

TABLE A-6
OSL ORDER OF MAGNITUDE ESTIMATE – HIGH COST
PERMEABLE REACTIVE BARRIER INSTALLATION

ITEM #	DESCRIPTION	UNIT	QTY.	UNIT PRICE	EXTENDED PRICE
1. PRE-INSTALLATION					
1a.	Bench Scale Test	ea.	1	$25,000.00	$25,000
1b.	Hydro Modeling	ea.	1	$50,000.00	$50,000
2. EARTHWORK					
2a.	Mobilization/Demobilization	ea.	1	$90,000.00	$90,000
2b.	Site Clearing	sq foot	27,000	$0.45	$12,150
2c.	Site Prep (earthwork/grading)	cubic yard	18,000	$4.30	$77,400
3. INSTALLATION					
3a.	Iron media, delivered	ton	4,000	$750.00	$3,000,000
3b.	PRB Construction	lump sum	1	$1,935,000.00	$1,935,000
3c.	Subcontractor design/licensing	lump sum	1	$760,000.00	$760,000
3d.	Monitoring well installation	ea.	34	$4,000.00	$136,000
3e.	PVC piping	lin ft.	1,000	$20.00	$20,000
3f.	Site Restoration	lump sum	1	$25,000.00	$25,000
3g.	Closeout/Reporting	lump sum	1	$50,000.00	$50,000
4. LANDSCAPING					
4.	Loam and Seed	square yard	3400	$1.30	$4,420
5. DISPOSAL OF EXCAVATED SOILS – NON-HAZARDOUS (20%)		ton	600	$48.00	$28,800
6. DISPOSAL OF EXCAVATED SOILS - HAZARDOUS (80%)		ton	2400	$195.00	$468,000
	PRB CONSTRUCTION SUBTOTAL:				$6,681,770
7. FIELD OFFICE					
7a.	Field Office, Misc	allowance	15%	$6,681,770.00	$1,002,266
7b.	Construction Engineering Services	allowance	20%	$6,681,770.00	$1,336,354
7c.	Health and Safety	allowance	10%	$6,681,770.00	$668,177
	PRB CONSTRUCTION SUBTOTAL:				$9,688,567
8. O&M					
8a.	Groundwater Monitoring *(quarterly Yr 1&2, semi-annually Yr 3, annually Yr 4-30)	present worth	*	$25,000.00	$466.225
8b.	Media Replacement (once – Yr 15)	present worth	1	$ 4,500,000.00	$1,629,000
				PRB O&M TOTAL:	$2,095,225
				PRB TOTAL:	$11,783,792
				HIGH COST FROM GW2:	$695,240
				HIGH COST GW3 TOTAL:	$12,479,032

APPENDIX B

PRESENT WORTH COSTS

LOW COST

PRESENT WORTH TABLES

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
QUARTERLY COMPLIANCE MONITORING
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	28000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	28000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	26,168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$26,168

YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
	TOTAL PRESENT WORTH O&M AT i=7%																$26,170

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
POST-COMPLIANCE MONITORING (SEMI-ANNUAL)
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	14000	14000	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	14000	14000	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	12,228	11,428	0	0	0	0	0	0	0	0	0	0	0	0	$23,656
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
		TOTAL PRESENT WORTH O&M AT i=7%																$23,660

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
FIVE-YEAR REVIEW
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
3. Annual Cost (Sum of Lines 1 and 2)	0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
4. Discount Factor (percent) 7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)	0	0	0	0	0	3,565	0	0	0	0	2,542	0	0	0	0	1,812	$7,919
YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
3. Annual Cost (Sum of Lines 1 and 2)	0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
4. Discount Factor (percent) 7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)	0	0	0	0	0	1292	0	0	0	0	921	0	0	0	0	657	$2,870
	TOTAL PRESENT WORTH O&M AT i=7%																$10,790

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
UTILITIES
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)			2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	2,336	2,184	2,041	1,907	1,782	1,666	1,557	1,455	1,360	1,271	1,188	1,110	1,037	970	906	$22,770
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
3. Annual Cost (Sum of Lines 1 and 2)		0	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	847	791	740	691	646	604	564	527	493	461	430	402	376	351	328	$8,253
		TOTAL PRESENT WORTH O&M AT i=7%																$31,020

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM O&M
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost			270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	
3. Annual Cost (Sum of Lines 1 and 2)		0	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	252	236	220	206	193	180	168	157	147	137	128	120	112	105	98	$2,459
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	
3. Annual Cost (Sum of Lines 1 and 2)		0	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	91	85	80	75	70	65	61	57	53	50	46	43	41	38	35	$891
		TOTAL PRESENT WORTH O&M AT i=7%																$3,350

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM EQUIPMENT REPAIR
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
3. Annual Cost (Sum of Lines 1 and 2)		0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	93	87	82	76	71	67	62	58	54	51	48	44	41	39	36	$911
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
3. Annual Cost (Sum of Lines 1 and 2)		0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	34	32	30	28	26	24	23	21	20	18	17	16	15	14	13	$330
												TOTAL PRESENT WORTH O&M AT i=7%						$1,240

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM REPLACEMENT
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1900	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1900	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	689	$689
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
		TOTAL PRESENT WORTH O&M AT i=7%																$690

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
SEMI-ANNUAL INDOOR AIR MONITORING
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	4000	4000	4000	4000	4000	0	0	0	0	0	0	0	0	0	1900	
3. Annual Cost (Sum of Lines 1 and 2)		0	4000	4000	4000	4000	4000	0	0	0	0	0	0	0	0	0	1900	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	3,738	3,494	3,265	3,052	2,852	0	0	0	0	0	0	0	0	0	689	$17,089
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
		TOTAL PRESENT WORTH O&M AT i=7%																$17,090

ALTERNATIVE GW3: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS/IN-SITU REMEDIAL ACTION
PRB REPLACEMENT
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4500000	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4500000	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1629000	$1,629,000
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
		TOTAL PRESENT WORTH O&M AT i=7%																$1,629,000

ALTERNATIVE GW3: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS/IN-SITU REMEDIAL ACTION
PRB MONITORING
PRESENT WORTH ESTIMATE OF COSTS - LOW COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost			100000	100000	50000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
3. Annual Cost (Sum of Lines 1 and 2)		0	100000	100000	50000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	93,458	87,344	40,815	19,072	17,825	16,659	15,569	14,550	13,598	12,709	11,877	11,100	10,374	9,695	9,061	$383,707
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
3. Annual Cost (Sum of Lines 1 and 2)		0	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	8468	7914	7397	6913	6450	6038	5643	5274	4929	4606	4305	4023	3760	3514	3284	$82,518
														TOTAL PRESENT WORTH O&M AT i=7%				$466,225

MEDIUM COST

PRESENT WORTH TABLES

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
QUARTERLY COMPLIANCE MONITORING
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	28000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	28000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	26,168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$26,168

YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0

	TOTAL PRESENT WORTH O&M AT i=7%	$26,170

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
POST-COMPLIANCE MONITORING (SEMI-ANNUAL)
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	0	28000	28000	28000	28000	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)	0	0	28000	28000	28000	28000	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent) 7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)	0	0	24,456	22,856	21,361	19,964	0	0	0	0	0	0	0	0	0	0	$88,637
YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent) 7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
	TOTAL PRESENT WORTH O&M AT i=7%																$88,640

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
FIVE-YEAR REVIEW
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	3,565	0	0	0	0	2,542	0	0	0	0	1,812	$7,919
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	1292	0	0	0	0	921	0	0	0	0	657	$2,870
												TOTAL PRESENT WORTH O&M AT i=7%						$10,790

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
UTILITIES
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	
4. Discount Factor (percent) 7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)	0	2,804	2,620	2,449	2,289	2,139	1,999	1,868	1,746	1,632	1,525	1,425	1,332	1,245	1,163	1,087	$27,324
YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	
3. Annual Cost (Sum of Lines 1 and 2)	0	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	
4. Discount Factor (percent) 7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)	0	1016	950	888	830	775	725	677	633	591	553	517	483	451	422	394	$9,903
	TOTAL PRESENT WORTH O&M AT i=7%																$37,230

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM O&M
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	
3. Annual Cost (Sum of Lines 1 and 2)	0	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	
4. Discount Factor (percent) 7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)	0	1,009	943	882	824	770	720	673	629	587	549	513	480	448	419	391	$9,837
YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	
3. Annual Cost (Sum of Lines 1 and 2)	0	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	
4. Discount Factor (percent) 7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)	0	366	342	320	299	279	261	244	228	213	199	186	174	162	152	142	$3,565
	TOTAL PRESENT WORTH O&M AT i=7%																$13,400

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM EQUIPMENT REPAIR
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost			500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	
3. Annual Cost (Sum of Lines 1 and 2)		0	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	467	437	408	381	356	333	311	291	272	254	238	222	207	194	181	$4,554
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	
3. Annual Cost (Sum of Lines 1 and 2)		0	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	169	158	148	138	129	121	113	105	99	92	86	80	75	70	66	$1,651
													TOTAL PRESENT WORTH O&M AT i=7%					$6,200

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM REPLACEMENT
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17460	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17460	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,328	$6,328
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
		TOTAL PRESENT WORTH O&M AT i=7%																$6,330

ALTERNATIVE GW3: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS/IN-SITU REMEDIAL ACTION
PRB REPLACEMENT
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4500000	
2. O&M Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4500000	
4. Discount Factor (percent) 7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1629000	$1,629,000
YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent) 7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
	TOTAL PRESENT WORTH O&M AT i=7%																$1,629,000

ALTERNATIVE GW3: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS/IN-SITU REMEDIAL ACTION
PRB MONITORING
PRESENT WORTH ESTIMATE OF COSTS - MEDIUM COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost			100000	100000	50000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
3. Annual Cost (Sum of Lines 1 and 2)		0	100000	100000	50000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	93,458	87,344	40,815	19,072	17,825	16,659	15,569	14,550	13,598	12,709	11,877	11,100	10,374	9,695	9,061	$383,707
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
3. Annual Cost (Sum of Lines 1 and 2)		0	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	8468	7914	7397	6913	6450	6038	5643	5274	4929	4606	4305	4023	3760	3514	3284	$82,518
												TOTAL PRESENT WORTH O&M AT i=7%						$466,225

HIGH COST

PRESENT WORTH TABLES

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
QUARTERLY COMPLIANCE MONITORING
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	28000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	28000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	26,168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$26,168

YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
														TOTAL PRESENT WORTH O&M AT i=7%			$26,170

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
POST-COMPLIANCE MONITORING (SEMI-ANNUAL)
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	28000	28000	28000	28000	28000	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	28000	28000	28000	28000	28000	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	24,456	22,856	21,361	19,964	18,658	0	0	0	0	0	0	0	0	0	$107,295
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
		TOTAL PRESENT WORTH O&M AT i=7%																$107,290

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
FIVE-YEAR REVIEW
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	3,565	0	0	0	0	2,542	0	0	0	0	1,812	$7,919
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	5000	0	0	0	0	5000	0	0	0	0	5000	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	1292	0	0	0	0	921	0	0	0	0	657	$2,870
												TOTAL PRESENT WORTH O&M AT i=7%						$10,790

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
SDW INSTALLATION
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	11000	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	11000	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	8,979	0	0	0	0	0	0	0	0	0	0	0	0	$8,979
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
												TOTAL PRESENT WORTH O&M AT i=7%						$8,980

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
UTILITIES
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)			6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	5,607	5,241	4,898	4,577	4,278	3,998	3,736	3,492	3,264	3,050	2,851	2,664	2,490	2,327	2,175	$54,647

YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	
3. Annual Cost (Sum of Lines 1 and 2)		0	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	2032	1899	1775	1659	1551	1449	1354	1266	1183	1105	1033	966	902	843	788	$19,807
		TOTAL PRESENT WORTH O&M AT i=7%																$74,450

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM O&M
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	
3. Annual Cost (Sum of Lines 1 and 2)	0	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	
4. Discount Factor (percent)																	YEAR
7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	0-15
5. Present Worth (Product of Lines 3 and 4)	0	2,019	1,887	1,763	1,648	1,540	1,439	1,345	1,257	1,175	1,098	1,026	959	896	838	783	$19,673

YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	
3. Annual Cost (Sum of Lines 1 and 2)	0	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	
4. Discount Factor (percent)																	YEAR
7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	16-30
5. Present Worth (Product of Lines 3 and 4)	0	732	684	639	597	558	522	488	456	426	398	372	348	325	304	284	$7,130
TOTAL PRESENT WORTH O&M AT i=7%																	$26,800

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM EQUIPMENT REPAIR
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
3. Annual Cost (Sum of Lines 1 and 2)	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
4. Discount Factor (percent)																	YEAR
7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	0-15
5. Present Worth (Product of Lines 3 and 4)	0	935	873	816	763	713	666	623	582	544	508	475	444	415	388	362	$9,108

YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
3. Annual Cost (Sum of Lines 1 and 2)	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
4. Discount Factor (percent)																	YEAR
7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	16-30
5. Present Worth (Product of Lines 3 and 4)	0	339	317	296	277	258	242	226	211	197	184	172	161	150	141	131	$3,301
TOTAL PRESENT WORTH O&M AT i=7%																	$12,410

ALTERNATIVE GW2: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS
VENTILATION SYSTEM REPLACEMENT
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34920	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34920	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,657	$12,657

YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
												TOTAL PRESENT WORTH O&M AT i=7%						$12,660

ALTERNATIVE GW3: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS/IN-SITU REMEDIAL ACTION
PRB REPLACEMENT
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4500000	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4500000	
4. Discount Factor (percent)	7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1629000	$1,629,000
YEAR			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																		
1. Capital Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3. Annual Cost (Sum of Lines 1 and 2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4. Discount Factor (percent)	7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0
		TOTAL PRESENT WORTH O&M AT i=7%																$1,629,000

ALTERNATIVE GW3: INSTITUTIONAL CONTROLS/MONITORING/ENGINEERING CONTROLS/IN-SITU REMEDIAL ACTION
PRB MONITORING
PRESENT WORTH ESTIMATE OF COSTS - HIGH COST
AMENDED FEASIBILITY STUDY
OLD SOUTHINGTON LANDFILL

PRESENT WORTH ANALYSIS (i=7%)

COST/YEAR COST OCCURS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost		100000	100000	50000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
3. Annual Cost (Sum of Lines 1 and 2)	0	100000	100000	50000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
4. Discount Factor (percent) 7	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	YEAR 0-15
5. Present Worth (Product of Lines 3 and 4)	0	93,458	87,344	40,815	19,072	17,825	16,659	15,569	14,550	13,598	12,709	11,877	11,100	10,374	9,695	9,061	$383,707

YEAR		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
COST COMPONENT																	
1. Capital Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2. O&M Cost	0	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
3. Annual Cost (Sum of Lines 1 and 2)	0	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	
4. Discount Factor (percent) 7	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	YEAR 16-30
5. Present Worth (Product of Lines 3 and 4)	0	8468	7914	7397	6913	6450	6038	5643	5274	4929	4606	4305	4023	3760	3514	3284	$82,518
	TOTAL PRESENT WORTH O&M AT i=7%																$466,225