DRAFT
Remedial Action Plan

Bay Shore Former MGP Site - Operable Unit -1
Bay Shore, New York
NYSDEC Consent Index No. D1-0001-98-11

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Executive Summary

This report presents a Remedial Action Plan (RAP) for the KeySpan Corporation (KeySpan) Bay Shore Former Manufactured Gas Plant (MGP) Site – Operable Unit –1 (OU-1) in Bay Shore, Suffolk County, New York (the Site). This report has been prepared in accordance with the Order on Consent, Index No. D1-0001-98-11, (the Order) signed by KeySpan and the New York State Department of Environmental Conservation (NYSDEC). The content and scope of the RAP were proposed during RAP scoping discussions with the NYSDEC and the New York State Department of Health (NYSDOH).

In accordance with the Order, the RAP was prepared in accordance with the Department-approved RI/FS Work Plan and in a manner consistent with CERCLA, the NCP, the USEPA guidance document entitled *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988)*, and appropriate USEPA and NYSDEC technical and administrative guidance documents.

Based on the findings of the Remedial Investigations, and the Human Health and Ecological Risk Assessments, and the NYSDEC remedy selection guidance, the following Remedial Action Objectives have been developed for the Site:

Groundwater

- Prevent, to the extent practicable, ingestion of groundwater with contaminant levels exceeding drinking water standards.
- Prevent, to the extent practicable, potential contact with contaminated groundwater and potential inhalation of volatiles from contaminated groundwater.
- Remove, where practicable, NAPL sources of groundwater contamination and prevent, to the extent practicable, the migration of chemicals from NAPL source areas to the groundwater within and downgradient of the operable unit causing exceedances of Standards, Criteria and Guidelines (SCGs).
- Prevent, to the extent practicable, off-site migration of groundwater in exceedance of SCGs.

Soil

- Prevent, to the extent practicable, human exposure to MGP-related chemicals present in the soil at levels exceeding SCGs.

In consideration of the site conditions and applicable regulations and guidance, the following remedial alternative is proposed for OU-1.

Excavating contaminant source material in the unsaturated zone, to a maximum depth of 8 feet, offsite thermal desorption of impacted soil, backfilling to existing grades with clean soil, performing in-situ chemical oxidation to treat/destroy residual source material in zones below 8 feet in the OU, recovering NAPL where practicable, and implementing institutional controls to manage future subsurface disturbance and resultant potential exposures.

This remedial alternative significantly reduces the existing contaminant mass. This mass reduction reduces the potential for future exposure to site-related contaminants in soil and groundwater. The flux of contaminants into groundwater is reduced by removal and destruction of source material, drastically reducing the contribution of contaminants to the downgradient plume (Operable Unit 2).

The alternative will allow and support a variety of future site uses. Institutional controls will be required to prevent and control potential exposure to remaining contaminants. However, these controls are readily implementable and future disturbance of remaining zones of contamination will be infrequent.

This alternative involves intensive remedial construction activity that will affect the current use of the residential properties not currently owned by KeySpan. Private property access will be addressed during the remedial design phase. Further analysis during the design phase may show that removal of the existing structures will lead to a more successful remediation than if the structures are allowed to remain.

Significant design and engineering is required prior to implementing the remedy, including pilot-scale testing of in situ chemical oxidation.

1. Purpose

1.1 Introduction

This report presents a Remedial Action Plan (RAP) for the KeySpan Corporation (KeySpan) Bay Shore Former Manufactured Gas Plant (MGP) Site – Operable Unit –1 (OU-1) in Bay Shore, Suffolk County, New York (the Site). This report has been prepared in accordance with the Order on Consent, Index No. D1-0001-98-11, (the Order) signed by KeySpan and the New York State Department of Environmental Conservation (NYSDEC). The content and scope of the RAP were proposed during the RAP scoping meeting held on November 21, 2002.

The Site is located West of Fifth Avenue, South of Ackerson Street and north of the Long Island Rail Road (LIRR) – Montauk Branch and is divided by Clinton Avenue. To efficiently manage the remediation of the area, it has been classified into four operable units. This report addresses remediation in the Operable Unit –1 (OU-1). OU-1 is defined as the Bay Shore site, Adjacent Off-site Areas south of the Bay Shore site and North of Union Boulevard and the Bay Shore West Parcel. A site location map is shown on Figure 1-1. The geographic boundaries of the operable units are shown on Figure 1-2.

The Site operations began in the late 1880s and continued into the 1970s. Most of the Site facilities were demolished in 1973. A site inspection conducted under the auspices of the United States Environmental Protection Agency in 1989 indicated the presence of subsurface impacts associated with former MGP operations. Subsequent investigations from 1992 through 2002 have comprehensively delineated and characterized these subsurface impacts. Interim Remedial Measures were conducted in January and February 1999 to locate, cut, drain and plug underground piping at the site perimeter associated with former MGP operations in the Bay Shore site and Bay Shore West Parcel and limit potential for off-site migration of MGP-derived waste materials.

The January 2003, *Bay Shore/Brightwaters Former Manufactured Gas Plant Site Final Remedial Investigation Report, Bay Shore, New York (Dvirka and Bartilucci (D&B), 2003)* and the April 2002, *Bay Shore/Brightwaters Former Manufactured Gas Plant Site Remedial Investigation Report, Bay Shore, New York (D&B, 2002)* (RI Reports) summarize the findings of all the investigations and remedial actions and recommend further remedial action to eliminate migration pathways and/or eliminate impacts.

1.2 Scope of Remedial Action Plan

The Order requires KeySpan to propose a "Remedial Plan" evaluating on-Site and off-Site remedial actions using factors set forth in 6 NYCRR 375-1.1(c). Based on the proposed plan, NYSDEC shall select a remedial response for the Site in consultation with KeySpan that eliminates or mitigates all significant threats to the environment or public health that hazardous materials constitute and allows the Contemplated Use of the Site to proceed safely. Further, the Order requires KeySpan to prepare and submit to NYSDEC a proposed Remediation Work Plan for public comment and approval.

This RAP was developed to meet the requirements of a "Remedial Plan" in accordance with the factors set forth in 6 NYCRR 375-1.1(c), *NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites* and NYSDEC Draft DER-10 Technical Guidance For Site Investigation and Remediation.

The results of this RAP will be used for selection of a final remedial response for OU-1, the preparation of a proposed Remediation Work plan, and the preparation of the Remedial Design, as described in the Order on Consent.

An interim remedial measure is being considered for the Bay Shore West portion of OU-1. This RAP does not evaluate nor propose any remedial action for the Bay Shore West parcel.

Future use of currently undeveloped portions of the Site is unknown at this time. Description and evaluation of remedial alternatives will assess the compatibility of the alternatives with multiple potential site uses.

1.3 Report Organization

This document has been organized in accordance with the NYSDEC Draft DER-10 Technical Guidance for Site Investigation and Remediation Section 4.3(b) and includes the following sections:

- Executive Summary
- Purpose
- Site Description and History
- Summary of Remedial Investigation and Exposure Assessment
- Remedial Goals and Remedial Action Objectives
- General Response Actions
- Identification and Screening of Technologies
- Development and Analysis of Alternatives

- Proposed Remedy and why it is selected

KeySpan and the NYSDEC agreed to expand the presentation of additional alternatives in this RAP beyond what would normally be required for a Voluntary Cleanup site (DER-10 section 4.3(d)), where only the proposed alternative need be described. The site is complex, and presenting and evaluating other alternatives gives added support to the proposed remedy. By documenting the consideration given to other, less suitable, approaches, potential questions of project stakeholders regarding alternatives to the proposed remedy may be answered in advance. The organization of this report therefore follows more closely that required for a Feasibility Study.

2. Site Description and History

This section presents a summary description of the site, its final history, previous investigations and interim remedial measures. Refer to the January 2003 Final RI Report and the April 2002 RI Report for more complete descriptions of the site and its history. As described in the January 2003 Final RI Report, to more effectively manage investigation and remediation activity, the MGP site has been divided into four operable units. As this RAP solely addresses OU-1, this Site Description section only describes OU-1.

2.1 Site (OU-1) Description

OU-1 encompasses approximately 8 acres as depicted on Figures 1-2 and 3-1 and currently includes the following:

- The Bay Shore Site, formerly the main operations area of the MGP, currently owned by KeySpan.
- A decommissioned Long Island Power Authority (LIPA) electric substation and a storage building located in northern portion of the property.
- An active KeySpan natural gas regulator station location in the northern portion of the property.
- The southern portion of the property is currently vacant and generally covered with grass, small trees and other low vegetation.
- A portion of the LIRR immediately south of the Bay Shore Site.
- The off-site area south of LIRR, north of Union Boulevard, east of Clinton Avenue and west of Fifth Avenue is a mixture of commercial and residential parcels. The parcel immediately south of LIRR along Clinton Avenue is owned by KeySpan and is vacant. The remaining off-site adjacent parcels are owned by others.
- A large portion of the Bay Shore West Parcel is currently vacant, with a small area used for KeySpan Gas Operations.

The entire Bay Shore Site and the Bay Shore West Parcel are enclosed by fencing and are secure from public access.

Surrounding properties include:

- ***North - Along Clinton and Fifth Avenue towards Ackerson Street***. Parcels with mixed commercial developments – auto service and retail businesses, and private residences.

- ***East - Fifth Avenue***. East of Fifth Avenue are parcels with mixed commercial and residential developments.

- ***South - Union Boulevard.*** The parcels are primarily private residences mixed with commercial businesses along Union Boulevard.

- ***West - Clinton Avenue and Bay Shore West Parcel.*** Immediately west of Clinton Avenue are Bay Shore West Parcel and Brightwaters Yard with a mixture of private residences and small commercial businesses.

2.2 Site History

A summary of the Bay Shore MGP history based on Dvirka & Bartilucci's (D&B) Remedial Investigation (RI) Report is presented below. A more detailed discussion of the MGP history is presented in D&B's April 2002 RI Report.

The Bay Shore MGP began operations in the late 1880s. The plant was operated by Mutual Gas and Light Company, The Suffolk Gas and Electric Light Company and later the Long Island Lighting Company (LILCO) in 1918. LILCO operated the plant from 1918 to approximately 1973 when most of the facilities were demolished. In 1998, KeySpan Corporation acquired the former MGP property through a merger of LILCO and Brooklyn Union Gas Company.

3. Summary of Remedial Investigation and Exposure Assessment

3.1 Introduction

Remedial Investigations have been conducted at the Site since 1989. The findings of those investigations are integrated into the April 2002 RI Report and January 2003 Final RI Reports. The January 2003 report presents a conceptual site model and comprehensive depiction of the nature and extent of contamination at the Site. The January 2003 Final RI Report also includes Qualitative Human Health and Ecological Risk Assessments. This section summarizes the findings presented in the January 2003 Final RI Report that are relevant to developing and analyzing remedial alternatives. Refer to the April 2002 RI Report and January 2003 Final RI Reports for a complete discussion of the remedial investigations conducted at the site.

3.2 Nature and Extent of Contamination

3.2.1 NAPL Source Material

The physical and chemical distribution of contaminants at the Bay Shore former MGP site OU-1 suggests the presence of five source areas of tar-saturated material in the subsurface. The five source areas are:

- The vicinity of the former 0.5 million cubic feet relief holder in the Former Gas Works Area
- The vicinity of the former tar separators in the Former Gas Works Area
- The vicinity of the former naphthalene scrubber
- The area south of the former 2 million cubic feet main holder
- The former light oil storage tanks located in the Bay Shore West Parcel

These source areas are defined by significant zones of tar-saturation and the presence of dense non-aqueous phase liquid (DNAPL) and light non-aqueous phase liquid (LNAPL), which coincide with the highest concentrations of polycyclic aromatic hydrocarbons (PAHs) and benzene, toluene, ethylbenzene, and xylene (BTEX) recorded in the subsurface and groundwater. The areal extent of NAPL impacts are depicted on Figure 3-1. The impacts observed on the Bay Shore West parcel are minor compared to the balance of OU-1, consisting of small areas of LNAPL and shallow groundwater contamination. Remediation of the Bay Shore West parcel should be relatively straightforward and can be efficiently addressed using an IRM.

3.2.2 Surface Soil

PAHs and BTEX were identified as contaminants of concern (COCs) in surface soil. These contaminants were detected throughout the site with higher concentrations in the vicinity of some of the former MGP structures. The surface of the site is primarily grass-covered with some areas covered by gravel, asphalt, structures, and sparsely vegetated areas with small trees and other shrubs. Migration of contaminants from the surface soil is possible at the site, but primarily through the transport of particulates. The nature of the COCs is such that they are relatively persistent in soils and would likely remain attached to soil particulates. PCB Aroclor-1260 was detected in the southwest corner of the site where several electric transformers were known to have been located.

3.2.3 Subsurface Soil

BTEX and PAHs were identified as COCs in subsurface soil. In general, the distribution of BTEX and PAHs in soil coincides with the presence of DNAPL. BTEX constituents in subsurface soils not associated with DNAPL are typically mobile and not particularly persistent in the surrounding environment due to their high volatility, low adsorption to soils, and high water solubility. With few exceptions, the PAHs associated with the site will be relatively persistent in the soil matrix and associated with DNAPL. This is primarily due to their generally low water solubility and high sorption to soils.

3.2.4 Groundwater

BTEX and PAHs have been identified as COCs in groundwater. The dissolved-phase groundwater contaminant concentrations within the area of DNAPL impacts are likely in a steady-state condition, where the rate of dilution from inflowing clean water and the rate of natural degradation processes equal the rate of dissolution of contaminants from the DNAPL. The likely age of the release (greater than 40 years) would have allowed the groundwater system on the site to reach steady state. The groundwater plume extends to approximately 3,400 feet south of OU-1 with the plume discharging to Lawrence Creek, a tidally influenced surface water body.

3.3 Qualitative Human Exposure Assessment

A qualitative human exposure assessment is included in the January 2003 Final RI Report. Based on the assessment, the following existing or potential exposure pathways are significant and require remedial action for their elimination or mitigation:

- Ingestion, dermal contact, and particulate inhalation of surface soil
- Inhalation, dermal contact, and particulate/vapor inhalation of subsurface soil
- Dermal contact of groundwater

Refer to the exposure assessment in the January 2003 Final RI Report for a more detailed discussion of the potentially exposed populations. Exposure to subsurface soil and groundwater would be expected to occur only during potential future ground-intrusive activities. Groundwater is not now used for consumptive purposes, nor is it reasonable to expect that it would be in the future.

3.4 Fish and Wildlife Resources Impact Analysis

A fish and wildlife resources impact analysis was also included in the January 2003 Final RI Report. The analysis concluded that the Site is having no significant impact on fish and/or wildlife resources. Accordingly, no remedial action is warranted to address potential ecological impacts.

3.5 Summary of Impacted Media and Contaminants of Concern

Based on the findings of the remedial investigations and exposure assessments, the impacted media requiring remedial action are surface soil, subsurface soil, NAPL source material, and groundwater. Potential human exposure to contaminants present in these media at the site requires mitigation via remedial action. There are no potential ecological exposures of significance. The potential exposure to groundwater is only anticipated to occur through infrequent ground intrusive construction-related activities.

Contaminants of concern are the volatile organics BTEX and PAHs.

3.6 Conceptual Model Development and Discussion

Using the physical observations and analytical results of the remedial investigation findings, a quantitative conceptual model describing the distribution impacted subsurface soil was developed for Operable Unit (OU-1).

3.6.1 Model Development

The operable unit was divided into three distinct zones: Bay Shore Site Area (KeySpan Parcel), Railroad Area and Off-site Area. The subsurface soils under each of these zones were further divided into eight discrete depth intervals. The intervals included: the unsaturated zone (zero to eight feet), eight to fifteen feet, and six additional ten-foot intervals spanning fifteen to seventy five feet. The physical observations from the borings in each of the zones and intervals were used to define the lateral extent of impact and estimate the potential volume of soil impacted. The analytical results from the soil samples collected in these respective intervals were averaged. In certain intervals, soil samples were not collected. In such intervals, the average analytical results were assumed to be similar to that of adjoining intervals with similar physical impacts. Using the average analytical results and estimated soil volume, the distribution of source material in the soil was calculated. Figure 3-2 illustrates this quantitative estimate of contaminant mass distribution.

3.6.2 Model Interpretation

The model presents the RI findings in the context of the geographic and stratigraphic setting of OU-1. This context is of critical importance in developing and evaluating remedial alternatives. From a geographic perspective, site access and existing infrastructure considerations can profoundly affect the implementability of a remedial approach. From a stratigraphic perspective, it becomes more technically difficult and costly to address contaminants present at increasing depths. A clear understanding of the relative distribution of contaminant mass within the OU provides insight when evaluating the relative merits, costs and risk-reduction benefits of remedial technologies and alternatives. This insight is also critical in evaluating the need for additional institutional action necessary to support the remediation, such as access to or control of property.

The relative distribution of contaminant mass is shown on Figure 3-2, and summarized as follows:

Zone/Depths	Portion of total OU-1 mass
Bay Shore Site Area – unsaturated zone	45 %
Bay Shore Site Area – saturated zone	10 %
LIRR – saturated zone	15 %
Off-site Area – water table smear zone, up to 10 feet deep	5 %
Off-site Area – below 25 feet deep	25 %

This distribution of contaminant mass is consistent with the model of contaminant migration presented in the RI report. Relatively little source material is present at depth within the on-site KeySpan site area. Of the estimated 10% of contaminant mass in the saturated zone there, most is located above a depth of 25 feet. Based on the fate and transport mechanisms established, it is likely that lighter source material migrated horizontally in a downgradient direction under the influence of groundwater flow. This premise is supported by the presence of physical impacts primarily in the groundwater smear zone ranging from 6 to 8 feet in the Off-site Area. Approximately 5% of the total mass is present in this shallow zone. Denser source material migrated vertically downward before migrating horizontally downgradient. Approximately 25% of total mass is present in the deeper (below 25 feet to approximately 70 feet) zone of the Off-site Area. The intermediate (10 to 25 feet) zone in the Off-site Area was estimated to contain less than 1% of the total mass.

Although no samples were collected in the Railroad Area during remedial investigations, it is presumed that source material was transported under the influence of groundwater flow through the intermediate (10 to 25 feet) zone. Based on the physical impacts identified in the boring logs and analytical results of samples collected north and south of the Long Island Railroad, it is estimated approximately 15% of the total mass is present in the intermediate (10 to 25 feet) zone below the Railroad Area.

The model highlights the following site conditions that will significantly affect the consideration and selection of remedial alternatives and technologies:

- Almost half the estimated contaminant mass is located above the water table within the KeySpan-owned portion of OU-1.

- Relatively little of the contaminant mass is located below 25 feet within the KeySpan-owned portion of OU-1.

- A significant amount of contamination is located at depths of 10 to 25 feet under the LIRR, an important part of the local and regional transportation infrastructure.

- Significant amounts of contamination are located south of the LIRR and north of Union Boulevard at depths of up to 70 feet. Several parcels within this area of the OU are not presently under KeySpan's control and are currently under residential use.

- The contamination under the residential parcels is present below the water table. Existing conditions do not include a completed human exposure pathway and do not prevent residential use. Access and issues associated with remedial action logistics and infrastructure needs will be addressed during the remedial design phase.

4. Remedial Goals and Remedial Action Objectives

4.1 Remedial Goals

The NYSDEC's Draft DER-10 Technical Guidance for Site Investigation and Remediation – Section 4.1(b) puts forth the following remedial goals for the voluntary cleanup program:

- Be protective of public health and the environment, given the intended use of the site.
- Where an identifiable source of contamination exists at a site, it should be removed or eliminated, to the extent feasible, regardless of presumed risk or intended use of the site.

While not required under the voluntary cleanup program, a preliminary evaluation of restoring the site to pre-release conditions is included in this RAP. The nature and extent of contamination at the Site, particularly the depth to which contaminants have migrated beneath the site, make it readily apparent that restoration to pre-release conditions is not feasible at the Site. Accordingly, restoration of the Site is not given any further consideration in this RAP. However, the magnitude of the scope and cost for conducting such a remedy is presented to demonstrate the infeasibility of the approach.

The two goals are then the Site Remedial Goals and will be applied to the Site as the site-specific Standards, Criteria and Guidelines (SCGs), under the applicable waiver and in accordance with TAGM 4030, for determining success of the final remedy.

4.2 Remedial Action Objectives

Remedial Action Objectives (RAOs) are medium-specific (e.g. soil, groundwater, air) or operable-unit specific objectives for the protection of public health and the environment. The RAOs for the Site support and are consistent with the Site Remedial Goals presented above. Based on the findings of the Remedial Investigations, and the Human Health and Ecological Risk Assessments, the following Remedial Action Objectives have been developed for the Site – OU-1:

Groundwater

- Prevent, to the extent practicable, ingestion of groundwater with contaminant levels exceeding drinking water standards.
- Prevent, to the extent practicable, potential contact with contaminated groundwater and potential inhalation of volatiles from contaminated groundwater.
- Remove, where practicable, NAPL sources of groundwater contamination and prevent, to the extent practicable, the migration of chemicals from NAPL source areas to the groundwater within and downgradient of the operable unit causing exceedances of SCGs.
- Prevent, to the extent practicable, off-site migration of groundwater in exceedance of SCGs.

Soil

- Prevent, to the extent practicable, human exposure to MGP-related chemicals present in the soil at levels exceeding SCGs.

The southern, downgradient border of OU-1 is the northern, upgradient border of OU-2. The remedial strategy and approach for OU-2 will depend upon the degree to which the remedial action objectives for OU-1 can be achieved. Given the nature and extent of contamination, the limitations of implementable technologies, and the site logistical constraints, the practicable degree of reduction in migration of contaminants from OU-1 to OU-2 that can ultimately be achieved by the selected remedy will likely result in some continued flux of contaminants between the OUs. That is, it is unlikely that the flux of contaminants from OU-1 to OU-2 can be completely eliminated. That resultant flux will be a driving factor in developing a remedial alternative for OU-2.

5. General Response Actions

5.1 General Response Actions

General response actions describe those actions that will satisfy the RAOs. General response actions are medium-specific. The general response actions are evaluated in the context of the volume or areas of media to which they might be applied. The general response actions described below include No Action, Excavation, Treatment, Containment, and Institutional Controls.

5.1.1 No Action

In many feasibility studies, the no action response is typically identified and carried through the evaluation process as a point of comparison for other actions. As this RAP is directed towards selection of appropriate remedial responses that are more likely to achieve the stated RAOs, no further consideration is given to the no action response.

5.1.2 Excavation

Excavation is applicable to the soil and contaminant source areas at the Site. Excavation of impacted soils, structures, and contaminant source areas in the unsaturated zone would be accomplished using conventional construction equipment and methods. Excavation in the saturated zone would require significant earth support and dewatering systems. Limited excavation of soils within the saturated zone up to depths of 25 feet will be considered. Given the high hydraulic conductivity, high water table, and the vertical extent of contamination, excavation of all impacted soils and NAPL is infeasible. However, estimates for this response are developed to provide an order of magnitude value for the restoration of the site to pre-release conditions. Soil or source materials removed by excavation would need to be further addressed by disposal or treatment.

5.1.3 Treatment

Treatment is applicable to the soil and source materials. Treatment alters the physical and/or chemical nature of the media to cause a change in contaminant mass, mobility, or toxicity. Treatment can be accomplished in-situ or ex-situ. Examples of in-situ treatment include chemical oxidation and stabilization. Ex-situ treatment technologies include thermal desorption and incineration.

5.1.4 Containment

Containment is applicable to the NAPL contaminant sources and soil at the site. For NAPL, containment actions involve isolation of contaminants by constructing and maintaining physical barriers or systems that prevent potential migration. These include sheet pile walls, soil-bentonite cutoff walls, and active hydraulic control. For soil, containment actions include constructing caps or other barriers to prevent contact with the soil.

5.1.5 Institutional Controls

Institutional controls are applicable to soil, NAPL sources and groundwater. These actions include access control measures, deed restrictions, and established procedures for managing ground-intrusive work.

6. Identification and Screening of Technologies

6.1 Introduction

In this step, the universe of potentially applicable technologies is reduced by evaluating the options with respect to technical implementability. During this step technologies are eliminated from further consideration on the basis of technical implementability. This is accomplished by using information developed in the remedial investigations on contaminant types and distribution and physical site characteristics to screen out technologies that cannot be effectively implemented at the site.

6.2 Technology Identification and Screening

Technology identification and screening involves the following steps:

- Assessment of technical issues posed by the site and the project.
- Identification of potentially applicable technologies.
- Preliminary screening of the technologies with respect to implementability, effectiveness and cost.

6.2.1 Technical Issues

The primary technical issues affecting the implementability and effectiveness of potential technologies at the site are: the physical and chemical nature of the source material and NAPL; the shallow depth to groundwater, and highly permeable soil; the deep vertical extent of contamination; the proximity of critical infrastructure (roads, railroad, utilities); structures and site access limitations; and potential future uses of the property.

MGP-derived NAPLs are complex chemical mixtures. The NAPLs present in the subsurface are not uniform in either their physical or chemical characteristics, likely having origins from different processes over a long time span. The weathering and mixing with soil and groundwater that has occurred over time has made these NAPLs even less of a pure, consistent product. This complexity, and the predominance of relatively “heavy” organics within the NAPL, mean that many remedial treatment technologies that have been proven for less complex, or “lighter” contaminants will not be effective on the NAPLs at the Site.

The hydrogeologic characteristics of the site pose several challenging issues. The relatively shallow depth to groundwater means that any significant excavation beyond 8 to 10 feet will require construction dewatering and earth support systems. Dewatering is most readily implementable when a significant stratum of relatively low permeability soil is within a reasonable depth from the surface. At the Site, a layer of low permeability clay exists at approximately 70 feet below the ground surface. If vertical barriers can be constructed to tie into this layer, then groundwater control within an excavation can be more efficiently maintained. However, the dewatering issues will be a significant component in any remedy involving large excavation area below the water table.

The relatively high hydraulic conductivity of the Site soils also pose issues for potential in-situ technologies, such as chemical oxidation, that require control of the subsurface environment.

The remedial investigations have shown that contamination extends vertically to approximately 70 feet within some portions of OU-1. As stated in the January 2003 RI Report, the contamination present at such depths appears to be source material for the dissolved phase plume. However, this depth is beyond the limits of practicable excavation technologies. Therefore, in this RAP, contamination below a depth of 25 feet will be addressed with in situ technologies, such as chemical oxidation, and alternatives will be developed in combination with other conventional technologies.

A portion of OU-1 is traversed by the Long Island Rail Road (LIRR), a very active and critical transportation system. Clinton Avenue and Union Boulevard are busy primary routes through the town. Gas, electric, water, telephone, sanitary sewer and storm sewer utility systems traverse or abut OU-1. The desire to prevent or minimize disruption to these critical components of the local infrastructure affects the consideration and potential effectiveness of the actions that could potentially be used to remediate the site.

Significant contaminant sources are located beneath properties that are not currently owned by KeySpan (LIRR, several parcels north of Union Boulevard). All remedial alternatives will require some degree of short-term and/or long-term access to these properties. The degree of access will vary among the alternatives and will be addressed during the remedial design phase.

While no specific future use for the KeySpan-owned portions of the Site is planned at this time, evaluation of remedial technologies and alternatives should consider the potential ramifications on future use. Given that the site cannot be restored to pre-release conditions, it is assumed that some type of institutional controls will be put in place to control future potential exposure to contaminants. These, together with potential removal, treatment and containment actions, will allow flexibility in redevelopment of the site while ensuring continued protection of human health and the environment.

6.2.2 Technology Identification

Potential remedial technologies were identified from experience and review of available technical publications. The technologies are categorized according to the general response actions developed in Section 5 and are summarized in Table 6-1.

6.2.3 Technology Screening

Table 6-1 also presents a screening evaluation of the technologies, according to the following criteria: effectiveness, implementability, and cost. As shown on Table 6-1, technologies that are not considered implementable or effective will not be retained for further analysis.

6.3 Summary of Retained Technologies

The technologies retained for further analysis are:

- Excavation
- Off-site low temperature thermal desorption
- Engineered cap and cover system
- NAPL recovery
- Hydraulic control
- Sheet pile containment
- In-situ stabilization
- In situ Chemical Oxidation
- In situ treatment of groundwater
- Monitoring only
- Institutional controls

In the next section, these technologies are combined into comprehensive site-wide alternatives.

7. Development and Analysis of Alternatives

7.1 Introduction

This section assembles retained remedial actions and technologies into a preliminary list of site-wide remedial alternatives. These preliminary alternatives are then screened based on their ability to meet medium-specific RAOs, their implementability, and their short-term and long-term effectiveness. The purpose of the screening is to reduce the number of alternatives that will undergo a more thorough and extensive analysis. The remaining alternatives are then described in detail and evaluated against seven criteria. Lastly, a comparative analysis of the alternatives is presented.

7.2 Preliminary Alternatives

In consideration of technological, Site, medium, and contaminant-specific factors, the following preliminary alternatives were developed for initial consideration and screening. To achieve the RAO to “remove, where practicable, identified sources of contamination at the Site”, all alternatives include excavation and off-site low temperature thermal desorption of contaminant source material in the unsaturated zone. All alternatives also include construction of a site-wide cap to limit disturbance of and prevent exposure to impacted soils. All alternatives also include institutional controls to limit subsurface disturbance and, when disturbance is necessary, to have a protocol in place to control potential exposure to contaminants. The preliminary alternatives are:

1. Excavate contaminant source areas in the unsaturated zone to a maximum of 8 feet below grade in the site area with off-site thermal treatment, install an in-situ chemical oxidation system to treat/destroy residual source material in zones below 8 feet throughout OU-1, and recover NAPL where practicable.

2. Excavate contaminant source material on the KeySpan parcel to a maximum depth of 25 feet below grade with off-site thermal treatment, install an in-situ chemical oxidation system to treat/destroy residual source material deeper than 25 feet on the KeySpan parcel and along the LIRR, and construct a perimeter containment wall and cap with hydraulic control for the off-site portion south of LIRR. Institute long-term monitoring, operation and maintenance of containment and hydraulic control systems.

3. Excavate contaminant source material on the KeySpan parcel to a maximum depth of 25 feet below grade with off-site thermal treatment, install an in-situ chemical oxidation system to treat/destroy residual source material deeper than 25 feet on the KeySpan parcel and along the LIRR and construct a funnel-and-gate type permeable reactive barrier wall along Union Boulevard. Institute long-term monitoring, operation and maintenance of the permeable reactive barrier system.

4. Excavate contaminant source areas in the unsaturated zone to maximum of 8 feet below grade in the KeySpan parcel with off-site thermal treatment, install an in-situ chemical oxidation system to treat/destroy residual source material along the LIRR and employ in-situ stabilization of source areas to a maximum depth of 70 feet below grade in the KeySpan parcel and the off-site area south of the LIRR..

5. Excavate source material to maximum of 70 feet below grade in the OU-1 area with off-site thermal treatment.

Table 7-1 presents an evaluation of the alternatives against the initial screening criteria of:

- Ability to meet medium-specific RAOs
- Implementability
- Short-term effectiveness
- Long-term effectiveness

As shown in Table 7-1, the first four alternatives will be retained for further analysis. The effectiveness of the fifth alternative is impracticable given the technical challenges and magnitude of the operation. The first four alternatives are retained and are described in more detail below.

7.3 Discussion of Alternatives Using the Conceptual Model

The preliminary alternatives were developed to address RAOs and minimize the resultant flux of dissolved contaminants to downgradient Operable Unit OU-2. In addition, the remedial alternatives were selected to remove, contain, or destroy to the extent practicable the mass of source material in the subsurface intervals of the various operable unit zones described in the development of the conceptual model in Section 3.6.

All the alternatives address the zones of contaminant source described in the conceptual model. In situ chemical oxidation is common to each alternative for the source material beneath the LIRR, as this will accomplish the objective with little or no requirements to directly access the LIRR property. All alternatives include some form of intensive activity in the off-site area south of the LIRR. Implementation of any of the alternatives will require significant access to the affected properties. The property access requirements are driven by remedial implementation logistics, and not by potential human exposure to contaminants.

7.3.1 Alternative 1

The shallow excavation in the unsaturated zone of the Site Area to a maximum of 8 feet below grade will remove approximately 45% of the total mass of source material in OU-1. The in situ chemical oxidation system will treat/destroy to the extent practical the remaining 55% of residual source material below 8 feet in the Site, Railroad and Off-site Areas. In addition, free-phase NAPL present in monitoring wells will be recovered. Through these actions, the resultant flux of dissolved contaminants to OU-2 will be minimized.

7.3.2 Alternative 2

The deeper excavation to a maximum depth of 25 feet below grade in the Site Area will remove approximately 55% of the total mass of source material. The in situ chemical oxidation system in the Railroad Area and deep zones of the Site Area will treat/destroy approximately 15% of the residual source material. A containment wall and cap with hydraulic control in the Off-site Area will limit the contribution of approximately 30% of the source material to the residual flux of dissolved contaminants to OU-2.

7.3.3 Alternative 3

The deeper excavation to a maximum depth of 25 feet below grade in the Site Area will remove approximately 55% of the total mass of source material. The in situ chemical oxidation system in the Railroad Area and deep zones of the Site Area will treat/destroy approximately 15% of the residual source material. A funnel and gate type permeable reactive barrier wall along Union Boulevard will limit the contribution of approximately 30% of the source material to the resultant flux of dissolved contaminants to OU-2.

7.3.4 Alternative 4

The shallow excavation in the unsaturated zone in the Site Area to a maximum of 8 feet below grade will remove approximately 45% of the total mass of source material in OU-1. The in situ chemical oxidation system in the Railroad Area and deep zones of the Site Area will treat/destroy approximately 15% of the residual source material. Using in situ stabilization, approximately 35% of source material mass will be immobilized in the Site Area, and Off-site Areas.

7.4 Description of Alternatives

Each of the four retained alternatives is described in more detail below, using the context of Section 4.2(a)5(i) of the NYSDEC Draft DER-10 Technical Guidance for Site Investigation and Remediation.

7.4.1 Alternative 1: Shallow Source Excavation/In Situ Oxidation

This alternative includes excavating contaminant source material and remnant MGP structures in the unsaturated zone, to a maximum depth of 8 feet, off-site thermal desorption of soil, backfilling to existing grades with clean soil, installing an in-situ chemical oxidation system to treat/destroy residual source material in zones below 8 feet throughout the OU, recovering free NAPL where practicable, and implementing institutional controls to manage future subsurface disturbance and resultant potential exposures. With respect to the guidance, the alternative is described as follows:

- ***Size and Configuration.*** Figure 7-1 illustrates the conceptual plans of this alternative. A major portion of the Site and off-site areas will be disturbed to some degree during excavation and installation of in-situ oxidation injection and monitoring points. Excavation of the entire impacted unsaturated zone will occur over approximately 90,000 square feet of Site area. Sheeting will be used along the LIRR and some dewatering may be necessary to enable excavation of source material with shallow groundwater zones. Based on observation of soil impacts during excavation, limited removal of soil in the saturated zone could also be performed, if determined that direct removal could be more effective than oxidation. The installation of in-situ oxidation injection and monitoring points will be sequenced in stages to study the effect of oxidant and rate of destruction. A NAPL recovery system will be used to remove free NAPL where present/feasible.

- ***Time for Remediation.*** The estimated time to complete all construction-related remediation activities, including excavation, backfilling, and oxidant injection is 1.5 years. Maintenance of institutional controls will continue indefinitely.

- ***Spatial Requirements.*** The alternative will require substantial room for equipment and material storage, access, logistics, and operation. The Site can accommodate these needs, but careful staging and sequencing of the work will be required. Further, access to all the parcels in the off-site areas of OU-1 will be required to install in-situ oxidant injection wells and control/monitor progress of remediation.

- ***Options for Disposal.*** Options for disposal of residual materials are readily available.

- ***Permit Requirements.*** Substantive technical permit requirements will be associated with demonstrating the effectiveness of in situ chemical oxidation.

- ***Effluent Discharge Permit***

- ***Limitations.*** The effectiveness of chemical oxidation at the field scale would need to be demonstrated by a pilot study at the site.

- ***Ecological Impacts.*** This alternative is not anticipated to have any significant beneficial or adverse impacts on fish and wildlife resources.

7.4.2 Alternative 2: Deep Source Excavation/Containment and Cap

This alternative includes excavating contaminant source material and remnant MGP structures to a maximum depth of 25 feet below grade with off-site thermal treatment, and installing an in-situ chemical oxidation system to treat/destroy residual source material deeper than 25 feet on the KeySpan parcel and along the LIRR. Excavations will be backfilled to existing grades with imported clean soil. For the off-site portion south of LIRR, a containment cell and engineered cap will be installed to restrict lateral mobility of deep source material. A groundwater recovery system will be installed for hydraulic control within the containment cell. A long-term monitoring, operation and maintenance plan for containment and hydraulic control systems will be instituted. In addition, institutional controls to manage future subsurface disturbance and resultant potential exposures will be developed. The containment cell will be constructed using conventional construction techniques and keyed into the clay layer over an aggregate area of 13,000 square feet. Sheets 70-foot long will be driven along the perimeter of the area. With respect to the guidance, the alternative is described as follows:

- ***Size and Configuration.*** Figure 7-2 illustrates the conceptual plans of this alternative. A significant area of the southern portion of the Site will be disturbed during excavation and the entire off-site area south of LIRR will be disturbed to construct the cap and containment cell. Excavation of the impacted saturated zone will occur over approximately 90,000 square feet of Site area.

- ***Time for Remediation.*** The estimated time to complete all construction-related remediation activities is 2.5 years. Operation and maintenance of the hydraulic control system and maintenance of institutional controls will continue indefinitely.

- ***Spatial Requirements.*** The alternative will require substantial room for equipment and material storage, access, logistics, and operation. The Site can accommodate these needs, but careful staging and sequencing of the work will be required. Access to all the parcels in the off-site areas of OU-1 will be required during the remedial construction phase. Long-term access to the off-site parcels will be required for system monitoring and maintenance.

Further, when containment sheets are installed adjacent to Clinton Avenue and Union Boulevard, it will likely be necessary to temporarily close the roads to traffic to accommodate construction equipment and control access to the areas undergoing remediation.

- ***Options for Disposal.*** Options for disposal of residual materials are readily available.

- ***Permit Requirements.*** Substantive technical permit requirements will be associated with demonstrating the effectiveness of in situ chemical oxidation, and establishing allowable flow rates and discharge limits for the temporary dewatering system and the permanent hydraulic control system. Estimated dewatering pumping rates of 350 gallons per minute will need to be sustained around the clock for an extended period of time.

- ***Limitations.*** The effectiveness of chemical oxidation at the field scale would need to be demonstrated by a pilot study at the site. Further analysis of dewatering and earth support requirements may identify technical or cost barriers to feasibility. Containment wall continuity and integrity at the depths contemplated are difficult to control.

- ***Ecological Impacts.*** This alternative is not anticipated to have any significant beneficial or adverse impacts on fish and wildlife resources.

7.4.3 Alternative 3: Deep Source Excavation/Permeable Reactive Barrier

This alternative includes excavating contaminant source material and remnant MGP structures to a maximum depth of 25 feet below grade with off-site thermal treatment, backfilling to existing grades with clean imported soil, installing an in-situ chemical oxidation system to treat/destroy residual source material deeper than 25 feet within the KeySpan parcel and along the LIRR, constructing a funnel and gate type permeable reactive barrier wall along Union Boulevard, instituting long-term monitoring, operation and maintenance of the permeable reactive barrier system and developing institutional controls to manage future subsurface disturbance and resultant potential exposures. With respect to the guidance, the alternative is described as follows:

- ***Size and Configuration.*** Figure 7-3 illustrates the conceptual plans of this alternative. The entire southern portion of the Site will be disturbed during excavation. Excavation of the source material impacted unsaturated zone will occur over approximately 90,000 square feet of Site area. Installation of permeable reactive barrier of approximately 500 linear feet long along Union Boulevard will likely require complete access to most parcels in the off-site area.

- ***Time for Remediation.*** The estimated time to complete all construction-related remediation activities is 2 years. Maintenance of the reactive barrier and maintenance of the institutional controls will continue indefinitely.

- ***Spatial Requirements.*** The alternative will require substantial room for equipment and material storage, access, logistics, and operation. The Site can accommodate these needs, but careful staging and sequencing of the work will be required. When permeable reactive barriers are installed adjacent to Union Boulevard, it will likely be necessary to temporarily close the road to traffic to accommodate construction equipment and control access to the areas undergoing remediation. Access to all the parcels in the off-site areas of OU-1 will be required during construction, with limited long-term access also required for system maintenance.

- ***Options for Disposal*.** Options for disposal of residual materials are readily available.

- ***Permit Requirements.*** Substantive technical permit requirements will be associated with demonstrating the effectiveness of in situ chemical oxidation, the effectiveness of the reactive barrier, and establishing allowable flow rates and discharge limits for the temporary dewatering system and the permanent hydraulic control system. Estimated dewatering pumping rates of 350 gallons per minute will need to be sustained around the clock for an extended period of time.

- ***Limitations.*** The effectiveness of chemical oxidation at the field scale would need to be demonstrated by a pilot study at the site. Further analysis of dewatering and earth support requirements may identify technical or cost barriers to feasibility. Continuity, compatibility and permanence are issues to be addressed for the permeable reactive barrier system. A treatability study for barrier components will be required.

- ***Ecological Impacts.*** This alternative is not anticipated to have any significant beneficial or adverse impacts on fish and wildlife resources.

7.4.4 Alternative 4: Shallow Source Excavation/Deep Source Stabilization

This alternative includes excavating contaminant source material and remnant MGP structures in the unsaturated zone to a maximum of 8 feet below grade in the site area with off-site thermal treatment, backfilling to existing grades with clean imported soil, in-situ stabilization of source material in on-site and off-site areas to a maximum depth of 70 feet below grade, in-situ chemical oxidation of source material along the LIRR, and institutional controls to manage future subsurface disturbance and resultant potential exposures. With respect to the guidance, the alternative is described as follows:

- ***Size and Configuration.*** Figure 7-4 illustrates the conceptual plans of this alternative. Excavation of the source material impacted unsaturated zone will occur over approximately 90,000 square feet of Site area. Soil stabilization will be employed to immobilize source material to 70 feet in depth over an aggregate area of 13,000 square feet of the KeySpan parcel and 50,000 square feet of the off-site parcels. This deep soil stabilization will be conducted by mixing cement, bentonite, and fly ash using auger equipment. Typically an area of 40 square feet is stabilized in each step of the mixing process and generally 20% of this area will be overlapped using sequential mixing points. The area beneath the LIRR will not be accessible to implement stabilization. Source material under the LIRR will be treated by in-situ chemical oxidation.

- ***Time for remediation.*** The estimated time to complete all construction-related remediation activities is 1.5 years. Maintenance of the institutional controls will continue indefinitely.

- ***Spatial Requirements.*** The alternative will require extensive room for equipment and material storage, access, logistics, and operation. The Site can accommodate these needs easily, but careful staging and sequencing of the work will be required. Access to all the parcels in the off-site areas of OU-1 will be required.

- ***Options for Disposal.*** Options for disposal of residual materials are readily available.

- ***Permit Requirements.*** Substantive technical permit requirements will be associated with demonstrating the effectiveness of in situ chemical oxidation and stabilization.

- ***Limitations.*** Continuity, compatibility, permanence, and alteration of groundwater hydraulics are issues to be addressed for the stabilization technology. The effectiveness of chemical oxidation at the field scale would need to be demonstrated by a pilot study at the site.

- ***Ecological Impacts.*** This alternative is not anticipated to have any significant beneficial or adverse impacts on fish and wildlife resources.

7.5 Evaluation Criteria

TAGM # 4030 Section 5.1.1 requires a detailed analysis of remedial alternatives against seven criteria and specifies specific factors to consider for each criterion. The seven criteria, also described in the NYSDEC Draft DER-10 Technical Guidance for Site Investigation and Remediation, are:

7.5.1 Overall Protection of Public Health and the Environment

This criterion is an evaluation of the remedy's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced or controlled through removal, treatment, engineering controls or institutional controls. The remedy's ability to achieve each of the RAOs is evaluated.

7.5.2 Compliance with Standards, Criteria, and Guidance (SCGs)

Compliance with SCGs addresses whether or not a remedy will meet applicable environmental laws, regulations, standards, and guidance. All SCGs for the site will be listed along with a discussion of whether or not the remedy will achieve compliance. For those SCGs that will not be met, provide a discussion and evaluation of the impacts of each, and whether waivers are necessary.

7.5.3 Long-term Effectiveness and Permanence

This criterion evaluates the long-term effectiveness of the remedy after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated:

- The magnitude of the remaining risks (i.e., will there be any significant threats, exposure pathways, or risks to the community and environment from the remaining wastes or treated residuals?)
- The adequacy of the engineering and institutional controls intended to limit the risk
- The reliability of these controls
- The ability of the remedy to continue to meet RAOs in the future

7.5.4 Reduction of Toxicity, Mobility or Volume with Treatment

The remedy's ability to reduce the toxicity, mobility or volume of site contamination is evaluated. Preference should be given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the site.

7.5.5 Short-term Effectiveness

The potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during the construction and/or implementation are evaluated. A discussion of how the identified adverse impacts and health risks to the community or workers at the site will be controlled, and the effectiveness of the controls, should be presented. Provide a discussion of engineering controls that will be used to mitigate short-term impacts (i.e., dust control measures). The length of time needed to achieve the remedial objectives is also estimated.

7.5.6 Implementability

The technical and administrative feasibility of implementing the remedy is evaluated. Technical feasibility includes the difficulties associated with the construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.

7.5.7 Cost

Capital, operation, maintenance and monitoring costs are estimated for the remedy and presented on a present worth basis.

7.6 Evaluation of Alternatives

7.6.1 Alternative 1: Shallow Source Excavation/In Situ Oxidation

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure to contaminants in surface pathways by removing source material in unsaturated zone, treating/destroying source material in-situ in saturated zones, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, ingestion of groundwater with contaminant levels exceeding drinking water standards.* Affected groundwater beneath OU-1 is not currently used for water supply and institutional controls will prevent its use in the future. In-situ treatment will significantly reduce the level of groundwater contamination, though not to drinking water standards.

- *Prevent, to the extent practicable, potential contact with contaminated groundwater and potential inhalation of volatiles from contaminated groundwater.* Institutional controls will prevent potential contact with contaminated groundwater. Shallow source removal and in-situ treatment will significantly reduce the level of shallow groundwater contamination, where the potential for future exposure is greatest.

- *Remove, where practicable, NAPL sources of groundwater contamination and prevent, to the extent practicable, the migration of chemicals from NAPL source areas to the groundwater within and downgradient of the operable unit causing exceedances of SCGs.* Significant source areas will be removed or treated, drastically reducing the migration of contaminants into groundwater. Some degree of downgradient migration will remain.

- *Prevent, to the extent practicable, off-site migration of groundwater in exceedance of SCGs.* The flux of contaminants into OU-2 will be reduced to the extent practicable by the removal and treatment of contaminant source areas.

- *Prevent, to the extent practicable, human exposure to MGP-related chemicals present in the soil at levels exceeding SCGs.* Exposures to soil are prevented by removing shallow soils and establishing institutional controls to prevent exposures to contaminants remaining in deeper soils. In situ chemical oxidation will reduce contaminant levels in deeper soils, further reducing the potential for exposure.

▪ ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** By removing the source material where feasible, and eliminating or controlling the exposure pathways, the alternative complies with the SCG's under the applicable waiver.

▪ ***Long-Term Effectiveness and Permanence.*** The magnitude of the remaining risks is small given the removal and treatment of source material, the depths at which contamination remains, and the institutional controls preventing future exposures. The proposed institutional controls are readily implementable and reliable. The RAOs can continue to be met in the future by maintaining the institutional controls.

▪ ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption of the excavated materials will reduce toxicity, mobility and volume significantly. In-situ chemical oxidation will reduce contaminant volume and mobility by destroying significant contaminant mass, particularly the more mobile of the contaminants of concern.

- ***Short-Term Effectiveness.*** The alternative will require intensive construction activity and some potential short-term impacts are expected. These potential impacts can be managed through careful planning and controls, such as suppression of odors, perimeter air monitoring, and implementation of health and safety and community awareness plans.

- ***Implementability.*** The alternative is technically implementable. The technologies are available commercially from multiple sources. The in-situ oxidation technology has been proven at similar sites on a limited scale. Bench testing and pilot testing will be required to develop scale up design parameters and kinetic data.

- ***Cost.*** The estimated cost is $33 million and is summarized in Table 7-2 and Table A-1.

7.6.2 Alternative 2: Deep Source Excavation/Containment and Cap

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing source material where feasible, treating/destroying residual source material where excavation not feasible, containing and capping the off-site source material, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, ingestion of groundwater with contaminant levels exceeding drinking water standards.* Affected groundwater beneath OU-1 is not currently used for water supply and institutional controls will prevent its use in the future.

  - *Prevent, to the extent practicable, potential contact with contaminated groundwater and potential inhalation of volatiles from contaminated groundwater.* Institutional controls will prevent potential contact with contaminated groundwater.

  - *Remove, where practicable, NAPL sources of groundwater contamination and prevent, to the extent practicable, the migration of chemicals from NAPL source areas to the groundwater within and downgradient of the operable unit causing exceedances of SCGs.* Significant source areas will be removed or treated, reducing the migration of contaminants into groundwater. Other source areas will be contained, not preventing continued migration to groundwater within the OU. The containment cell will prevent migration downgradient of the OU.

- *Prevent, to the extent practicable, off-site migration of groundwater in exceedance of SCGs.* The flux of contaminants into OU-2 will be reduced to the extent practicable by the removal, treatment or containment of contaminant source areas.

- *Prevent, to the extent practicable, human exposure to MGP-related chemicals present in the soil at levels exceeding SCGs.* Exposures to soil are prevented by removing shallow soils and establishing institutional controls to prevent exposures to contaminants remaining in deeper soils.

- ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** By removing the source material where feasible, and treating, eliminating or controlling the exposure pathways, the alternative complies with the SCG's under the applicable waiver.

- ***Long-Term Effectiveness and Permanence.*** The magnitude of the remaining risks is moderate. The proposed institutional controls are readily implementable and reliable. Maintenance of a cap is straightforward and readily achievable. Long-term performance of the containment cell could be questionable and should not be considered a permanent solution, given the persistence of the COCs in the subsurface. The RAOs can continue to be met in the future by maintaining the cap, control system and institutional controls.

- ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption of the excavated materials will reduce toxicity, mobility and volume significantly. In situ treatment will reduce volume and mobility of contaminants. The containment cell will reduce mobility, but will not reduce volume or toxicity.

- ***Short-Term Effectiveness.*** The alternative will require intensive construction activity and some potential short-term impacts are expected. These potential impacts can be managed through careful planning and controls, such as suppression of odors, perimeter air monitoring, and implementation of health and safety and community awareness plans.

- ***Implementability.*** The alternative is technically implementable, although the containment of saturated zone source material may present significant challenges in maintaining hydraulic control due to the depth of containment required. Access constraints to the off-site area may restrict the ability to construct the containment cell. The technologies are available commercially from multiple sources.

- ***Cost.*** The estimated cost is $41.5 million and is summarized in Table 7-2 and Table A-2.

7.6.3 Alternative 3: Deep Source Excavation/Permeable Reactive Barrier

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing source material to the extent feasible, installing a permeable reactive barrier along Union Boulevard, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, ingestion of groundwater with contaminant levels exceeding drinking water standards.* Affected groundwater beneath OU-1 is not currently used for water supply and institutional controls will prevent its use in the future.

  - *Prevent, to the extent practicable, potential contact with contaminated groundwater and potential inhalation of volatiles from contaminated groundwater.* Institutional controls will prevent potential contact with contaminated groundwater.

  - *Remove, where practicable, NAPL sources of groundwater contamination and prevent, to the extent practicable, the migration of chemicals from NAPL source areas to the groundwater within and downgradient of the operable unit causing exceedances of SCGs.* Significant source areas will be removed or treated, reducing the migration of contaminants into groundwater. Other source areas will be contained, not preventing continued migration into groundwater within the OU. The reactive barrier system will prevent migration downgradient of the OU.

  - *Prevent, to the extent practicable, off-site migration of groundwater in exceedance of SCGs.* The flux of contaminants into OU-2 will be reduced to the extent practicable by the removal, treatment or containment of contaminant source areas.

  - *Prevent, to the extent practicable, human exposure to MGP-related chemicals present in the soil at levels exceeding SCGs.* Exposures to soil are prevented by removing shallow soils and establishing institutional controls to prevent exposures to contaminants remaining in deeper soils.

- ***Compliance with Standards, Criteria, and Guidelines (SCGs):*** By removing the source material where feasible, treating saturated zone source material and eliminating or controlling the exposure pathways, the alternative complies with the SCG's under the applicable waiver.

- ***Long-Term Effectiveness and Permanence.*** The magnitude of the remaining risks is moderate. The proposed institutional controls are readily implementable and reliable. Maintenance of a site permeable reactive barrier is relatively complex but achievable. The RAOs can continue to be met in the future by maintaining the reactive barrier and the institutional controls.

- ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption of the excavated materials will reduce toxicity, mobility and volume significantly. In situ treatment reduces the toxicity of saturated zone source materials.

- ***Short-Term Effectiveness.*** The alternative will require significant construction activity and some potential short-term impacts are expected during excavation of the unsaturated areas. These potential impacts can be managed through careful planning and controls, such as suppression of odors, perimeter air monitoring, and implementation of health and safety and community awareness plans.

- ***Implementability.*** The alternative is technically implementable, although construction of the reactive barrier will present significant challenges. Access constraints to the off-site area may restrict the ability to construct the reactive barrier system. Technologies are available commercially from multiple sources.

- ***Cost.*** The estimated cost is $44.5 million and is summarized in Table 7-2 and Table A-3.

7.6.4 Alternative 4: Shallow Source Excavation/Deep Source Stabilization

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing shallow source material, stabilizing deep source areas, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, ingestion of groundwater with contaminant levels exceeding drinking water standards.* Affected groundwater beneath OU-1 is not currently used for water supply and institutional controls will prevent its use in the future.

- *Prevent, to the extent practicable, potential contact with contaminated groundwater and potential inhalation of volatiles from contaminated groundwater.* Institutional controls will prevent potential contact with contaminated groundwater.

- *Remove, where practicable, NAPL sources of groundwater contamination and prevent, to the extent practicable, the migration of chemicals from NAPL source areas to the groundwater within and downgradient of the operable unit causing exceedances of SCGs.* Significant source areas will be removed or treated, reducing the migration of contaminants into groundwater within and downgradient of the OU.

- *Prevent, to the extent practicable, off-site migration of groundwater in exceedance of SCGs.* The flux of contaminants into OU-2 will be reduced to the extent practicable by the removal, treatment or containment of contaminant source areas.

- *Prevent, to the extent practicable, human exposure to MGP-related chemicals present in the soil at levels exceeding SCGs.* Exposures to soil are prevented by removing shallow soils and establishing institutional controls to prevent exposures to contaminants remaining in deeper soils.

▪ ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** By removing the source material where feasible, immobilizing saturated zone source material and eliminating or controlling the exposure pathways, the alternative complies with the SCG's under the applicable waiver.

▪ ***Long-Term Effectiveness and Permanence.*** The magnitude of the remaining risks is small given the removal and treatment of source material, the depths at which contamination remains, and the institutional controls preventing future exposures. The proposed institutional controls are readily implementable. The RAOs can continue to be met in the future by maintaining the cap and the institutional controls. The permanence of in-situ stabilization of organic contaminants has not been extensively demonstrated.

▪ ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption of the excavated materials will reduce toxicity, mobility and volume significantly. In situ stabilization reduces the mobility of saturated zone source materials and hence its toxicity.

- ***Short-Term Effectiveness.*** The alternative will require significant construction activity and some potential short-term impacts are expected during excavation of the unsaturated areas. These potential impacts can be managed through careful planning and controls, such as suppression of odors, perimeter air monitoring, and implementation of health and safety and community awareness plans.

- ***Implementability.*** The alternative is technically implementable, although the deep stabilization will present significant challenges. The technologies are available commercially from multiple sources. However, stabilization mixtures will have to be developed for site-specific conditions using treatability tests. The period of implementation will be affected by specialized mixtures and techniques required to effect stabilization in the saturated zone. Access constraints to the off-site area may restrict the ability to perform stabilization.

- ***Cost.*** The estimated cost is $52.0 million and is summarized in Table 7-2 and Table A-4.

7.7 Comparison of Alternatives

Table 7-2 summarizes estimated remedial costs for the alternatives. Table 7-3 presents a comparative matrix of the alternatives with the evaluation criteria. A qualitative scoring system has been used to give a general sense of how the alternatives differ in meeting each of the criteria. This scoring system is somewhat subjective, but can provide some insights into the relative strengths and limitations of the alternatives. Each of the alternatives satisfies the criteria to some degree. The primary differences are found in long-term effectiveness, short-term effectiveness, implementability, and cost.

8. Proposed Remedy

Alternative 1 is the proposed remedy. As described in Section 7.6.1, the RAO's are achieved through a combination of excavation, in situ treatment and institutional controls. Source removal and destruction will dramatically reduce the ongoing contribution of OU-1 source materials to the downgradient groundwater plume (OU-2). With the mass flux from OU-1 to OU-2 reduced to a fraction of its current state, attenuation of the OU-2 plume can be more readily achieved.

Excavation of the unsaturated zone on the KeySpan parcel removes approximately 45% of the contaminant mass. Deeper excavation on the KeySpan parcel as proposed in alternatives 2 and 3 is not practicable as the costs and effort required only result in the removal of an additional 10% of the contaminant mass. In situ chemical oxidation of the deeper source material will effectively reduce the flux of contaminants from soil and NAPL into groundwater.

Chemical oxidation beneath the LIRR was a component of all alternatives due primarily to the inability to disrupt operations of the railroad. Oxidation can be accomplished with access only to the fringes of the LIRR property, or possibly even without access to the property, depending upon persistence of oxidants that could be injected immediately upgradient of the LIRR. This possibility would be evaluated through a pilot scale testing program.

Chemical oxidation beneath the off-site portions of OU-1 offers the best chance of successfully achieving the RAO's when compared to the other alternatives. It will be logistically very difficult to construct a containment system in this area, given the proximity to local streets and utilities. Access to the off-site properties will still be required. However, the complications of working around the existing structures is not as great as those for the stabilization alternative. While these complications may be significant and impact the treatment program, it may be possible to work around most of the structures with the injection equipment.

The institutional controls required as part of this remedy are straightforward and readily implementable and will reliably prevent exposures. No groundwater is currently being used within the OU and preventing new wells from being installed will ensure that none will be in the future. Future routine excavation activity within the unsaturated zone will not need to be controlled. Deeper excavation activity can be controlled through prescribed methods and protocols for managing work, groundwater and soils.

The remedy will be effective over the long term, requiring little long-term operations and maintenance. With proper maintenance of institutional controls, the remedy will support a variety of potential future land uses, including residential use.

Many issues and details related to the implementation of the remedy will be resolved in the upcoming design phase. Design of the chemical oxidation application requires both bench and pilot-scale testing. Bench-scale testing is currently underway. Results of these studies will be used to determine the oxidant(s) to be used and optimal oxidant dosing rates, locations, and methods. The design will also include methods for determining efficacy of treatment during implementation.

The design process will also identify and resolve issues related to excavation and the project's impact on the local community during implementation, such as dust and odor control and truck traffic. Property access and occupancy issues must also be resolved during the design phase.

References

Dvirka and Bartilucci Consulting Engineers, April, 2002. *Remedial Investigation Report, Bay Shore/Brightwaters Former MGP Site.*

Dvirka and Bartilucci Consulting Engineers, January, 2003. *Final Remedial Investigation Report, Bay Shore/Brightwaters Former MGP Site.*

New York State Department of Environmental Conservation, 1994. *Division Technical and Administrative Guidance Memorandum [TAGM 4046]: Determination of Soil Cleanup Objectives and Cleanup Levels*. Division of Hazardous Waste Remediation. Albany, New York.

New York State Department of Environmental Conservation, 1990. *Division Technical and Administrative Guidance Memorandum [TAGM 4030]: Selection of remedial Actions at Inactive Hazardous Waste Sites*. Division of Hazardous Waste Remediation. Albany, New York.

New York State Department of Environmental Conservation, December 2002. Draft DER-10 Technical Guidance for Site Investigation and Remedation, provided by R. Schick.

Tables

Table 6-1
Summary of Remedial Technology Screening
Bay Shore Former MGP Site – OU-1
Bay Shore, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
Excavation	Unsaturated Zone Excavation	Effective in elimination of exposure pathway and providing long-term protection of human health. Involves excavation to depth of about 8 feet in much of the site area. Residual contaminants may pose future threat to construction workers depending on site usage. Combined with institutional controls or cap, RAOs can be met.	Technology proven and readily implemented. Large scale removal necessary and will require dust, emissions and odor controls.	Low relative to other removal options.	Retained for alternative development.
	Saturated Zone Excavation	Effective in elimination of exposure pathway and providing long-term protection of human health. Involves removal to a depth of about 70 feet in areas of source material in the site area. Residual contaminants will not pose future threat to workers and eliminates potential off-site migration. Combined with a cap, RAOs can be met.	Technology proven and readily implemented. Very large scale removal necessary and will require dust, emissions and odor controls.	High relative to other removal options.	Retained for alternative development.
Ex-Situ Treatment	Off-site Low Temperature Thermal Desorption	Effective form of treatment of soils with low to high levels of organic contamination. Technology has been used at other similar sites effectively.	Readily implemented. Many permitted facilities can receive waste streams.	Medium compared to other ex situ treatment technologies.	Retained for alternative development.
	Slurry Phase Bioreactors	Technology in developmental stage for MGP waste streams. Effectiveness should be field tested before implementation.	Technology not proven.	Costs may be high compared to other ex-situ technologies.	Not Retained.
In Situ Treatment	Steam Assisted Dual Phase Extraction	Effective on small areas.	Readily implemented. May not be effective on some PAHs and source material.	Capital costs may be medium. Operation and maintenance costs may be high when compared to other in situ technologies.	Not Retained.
	In-Well air stripping	Effective in removing volatile organic compounds.	Not effective on PAHs.		Not Retained.
	Surfactant/Cosol-vent flushing	Effective in mobilizing NAPL and when combined with other recovery technologies may achieve RAOs.	Technology proven in controlled settings.	High capital costs when compared to other alternatives.	Not Retained.

Table 6-1
Summary of Remedial Technology Screening
Bay Shore Former MGP Site – OU-1
Bay Shore, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
In Situ Treatment	In-Situ Oxidation with Persulfate/O_3/ H_2O_2	Effective in destroying source material and meeting the RAOs at similar sites.	Technology proven.	Primarily driven by chemical and delivery costs. May be high compared to other alternatives.	Retained for alternative development.
	Monitored Natural Attenuation	Effective in destroying light end source material such as BTEX and naphthalene using naturally occurring processes and meeting the RAOs at similar sites.	Technology proven.	Low compared to other alternatives.	Retained for alternative development.
	Permeable Reactive Barriers	Effective in destroying dissolved components of source material and limiting down gradient migration.	Technology proven, however, depth may pose technical challenges.	High compared to other alternatives.	Retained for alternative development.
	Six Phase Heating	Effective in low volumes. Extent of impact at Bay Shore limits use.	Technology proven but the site area and volume of soils to be treated make it difficult to implement.	High compared to other alternatives.	Not Retained.
Containment	Engineered cap/cover system	Effective at controlling the pathways for future worker exposure.	Technology proven and readily implemented.	Medium compared to other technologies. Requires extensive earthwork.	Retained for alternative development.
	NAPL Recovery	Effective at capturing subsurface fluids. May capture more water. Modeling must be performed to predict favorable zones of capture.	Technology proven and readily implemented.	Low installation costs, but higher operation and maintenance costs relative to other technologies.	Retained for alternative development.
	Hydraulic Control	Effective in maintaining hydraulic gradient into the contained area. High groundwater velocity may require increased pumping rates and complex pumping arrangements.	Technology proven and readily implemented.	Low capital cost, high long-term maintenance cost relative to other technologies.	Retained for alternative development.

Table 6-1
Summary of Remedial Technology Screening
Bay Shore Former MGP Site – OU-1
Bay Shore, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
Containment	Sheet pile wall	Effective at meeting RAO for preventing migration and terminating exposure. Minimal disturbance of soils. Continuity and compatibility are concerns. Proximity to LIRR, Clinton Avenue and Union Boulevard may be a concern.	Technology proven and readily implemented. Starter trench may be used to remove near surface debris and obstructions.	Medium relative to other containment technologies.	Retained for alternative development.
	Soil/bentonite cutoff wall	Effective at meeting RAO for preventing migration and terminating exposure. However, wall construction may be difficult due to sandy soil.	Technology proven but materials and debris handling will require additional controls during installation. May need to construct under temporary enclosure to prevent emissions and odors.	High relative to other containment technologies.	Not retained.
	Jet Grouting	Effective at meeting RAO for preventing migration and terminating exposure.	Technology proven but site specific issues such as compatibility and continuity are issues to be addressed.	High relative to other containment technologies.	Retained for alternative development
	In Situ Stabilization	Effective at meeting RAO for preventing migration and terminating exposure. However, large-scale construction may pose difficulties.	Technology proven but site-specific materials may be needed.	High relative to other containment technologies.	Retained for alternative development.
Institutional Controls	Access Controls Deed Restrictions Health & Safety Plans Long-Term Monitoring Notifications	Effective in preventing risks to future construction workers. Not effective in limiting migration.	Readily implementable.	Low. Monitoring to be performed semi-annually.	Retained for alternative development.

Table 7-1
Remedial Action Alternatives - Initial Screening
Bay Shore Former MGP Site – OU-1
Bay Shore, New York

Remedial Action Alternative	Ability to Achieve RAO's	Implementability	Short-Term Effectiveness	Long-Term Effectiveness	Retained for Detailed Analysis?
Shallow excavation, treatment/destruction of source material with In Situ Chemical Oxidation, recovery of NAPL where feasible. Source area structures removal.	Achieves RAOs to some extent by eliminating potential exposure to source. Eliminates potential exposure in the down gradient area.	Executed with conventional excavating equipment. However, installation of in-situ oxidant delivery and monitoring wells will require access to off-site parcels.	Effective in eliminating significant exposure pathway.	May not reduce all impacted soils to cleanup criteria. Deep NAPL sources may not be destroyed. Long-term migration eliminated effectively.	Yes – though highly effective if In Situ Oxidation and/or deed restrictions eliminate exposure pathways to remaining impacted soils. Deeper source material may not be destroyed. However, off-site migration potential eliminated.
Deep excavation to a maximum depth of 25 feet, in-situ chemical oxidation in select areas near LIRR, Containment Cell with Cap south of LIRR and hydraulic control within containment cell.	Achieves RAO by eliminating exposure to source material. Also controls migration in the saturated zones.	Requires installation of containment barriers to 70 feet depth using special construction techniques. Requires construction of dewatering (large volumes) handling system. Requires modeling to design hydraulic control. Special containment wall material necessary for long-term reliability	Eliminates significant exposure pathway.	Effectively limits potential lateral mobility of source.	Yes – moderate effectiveness. Requires post closure long-term monitoring program to ensure effectiveness.
Excavation and treatment/ disposal of source material to a maximum depth of 25', in-situ chemical oxidization in select areas near LIRR, funnel and gate type Permeable Reactive Barrier south of LIRR along Union Boulevard.	Removes source of impacts. Achieves RAO as soil concentrations are likely to be reduced to cleanup criteria in many areas.	Executed with conventional excavating equipment. Requires construction of dewatering (large volumes) handling system. Requires installation of reactive barriers to 70 feet depth using special construction techniques.	Effective in eliminating significant exposure pathway.	Effective in eliminating long-term migration pathway.	Yes – moderately effective and requires post closure long-term monitoring program to ensure effectiveness.

Table 7-1
Remedial Action Alternatives - Initial Screening
Bay Shore Former MGP Site – OU-1
Bay Shore, New York

Remedial Action Alternative	Ability to Achieve RAO's	Implementability	Short-Term Effectiveness	Long-Term Effectiveness	Retained for Detailed Analysis?
Shallow excavation in source areas with enhanced in-situ deep soil stabilization.	Achieves RAO by eliminating exposure to and migration of source material.	Requires removal and disposal of surface soils to make room for increased volume of stabilized soils. Will require access to off-site residential properties. May require pre-excavation of debris and cobbles to accommodate auger mixing. Requires verification of stabilization due soil mixing limitations.	Effective in eliminating significant exposure pathway.	If a continuous area of stabilization is created, this alternative will immobilize NAPL in deep soils and prevent long-term migration.	Yes - moderate expected effectiveness. Long term monitoring required to prove effectiveness.
Deep excavation of all source areas and removal of structures.	Achieves RAO by removing all source material and eliminating exposure.	May not be feasible due to technology limitations to excavate to 70 feet. Will require construction of large volume dewatering system. Not cost-effective in achieving the contemplated site use.	Effective in removing source material and eliminating exposure pathway.	Effective in removing source material and eliminating exposure pathways.	No - effectiveness on eliminating exposure pathways countered by lack of cost-effectiveness and technical limitations.

Table 7-2
Estimated Remedial Component Costs
Bay Shore Former MGP Site – OU-1
Bay Shore, New York

Remedial Area	Remedial Action	Estimated Remedial Component Cost (millions of dollars)			
		Alternative 1 Excavate Shallow, ISCO[1] in all Deep Areas, NAPL Recovery	Alternative 2 Deep Source Excavation, ISCO near LIRR Off-Site Cap and Containment	Alternative 3 Deep Source Excavation, ISCO near LIRR, Permeable Reactive Barriers	Alternative 4 Shallow Source Excavation, ISCO near LIRR, Deep Soil Stabilization
OU-1 - Site Area, LIRR and Off-site Areas	Excavate & Backfill Source Areas	4.6	20.1	20.1	4.6
	ISCO	16.8	1.3	1.3	1.3
	Containment Cell and Cap	NA[2]	4.1	NA	NA
	Permeable Reactive Barrier	NA	NA	5.0	NA
	Deep Soil Stabilization	NA	NA	NA	30.2
	Long-Term Monitoring/Maintenance	1.1	2.7	4.2	1.2
	NAPL Recovery	0.1	NA	NA	NA
OU-1 Wide Costs	Design, Construction Management, and Mobilization, Restoration	3.8	5.0	5.0	4.3
	Contingency	6.6	8.3	8.9	10.4
	TOTALS[3]	**33.0**	**41.5**	**44.5**	**52.0**

Notes:
1. ISCO – In Situ Chemical Oxidation
2. NA - Not Applicable
3. Differences between total costs and sum of component costs are due to rounding

.

Table 7-3
Remedial Action Alternatives – Comparative Analysis
Bay Shore MGP Site – OU-1
Bay Shore, New York

Criteria	Sub-Criteria	Rating[1] Alt. 1: Excavate Shallow Source, ISCO, NAPL recovery	Alt. 2: Excavate Deep Source, ISCO, Contain and Cap	Alt. 3: Excavate Deep Source, ISCO, & PRB for Deep Impacts	Alt. 4: Excavate Shallow Source, and Stabilize Deep Impacts	Comparison Statement
Overall Protection of Human Health and the Environment		1	1	1	1	All of the alternatives would be equally protective of human health and the environment
	Score	**1**	**1**	**1**	**1**	
New York State or Site-Specific SCGs	Soil	1	3	2	1	All source removal actions, treatment, and soil stabilization will remove or immobilize impacts to soil at the Site. All removal actions and containment alternative eliminate potential exposure pathways and meet the site-specific remedial goals.
	Groundwater	1	3	2	3	All source removal actions, treatment, and soil stabilization will remove or immobilize impacts at the Site. These actions and containment alternative will remove the continuing source of shallow and intermediate groundwater impacts.
	Score	**2**	**6**	**4**	**4**	
Long-Term Effectiveness and Permanence	Permanence of Remedial Alternative	2	3	3	3	All of the alternatives are expected to be a permanent remedy for the Site. However, potential void between soil stabilization columns and deterioration of containment wall could result in the future migration of NAPL.
	Magnitude of Remaining Risk	1	4	3	2	Alternative 1 poses the least risk that additional remediation work will be required in the future
	Adequacy of Controls	1	4	3	1	The Deed/Land Use Restriction placed on the Site will sufficiently control any potential future exposures to impacts left in place after the final remedy.
	Reliability of Controls	1	3	2	3	For alternatives with barrier walls, the potential exists that repairs may be required in the future. For all alternatives with in-situ chemical oxidation (ISCO), potential exists that desorption effects may require additional application of oxidant.
	Score	**5**	**14**	**11**	**9**	

Note:
1. Score is based on a qualitative scale (1 = alternative compares very favorably to sub-criteria; 2 = alternative compares favorably to sub-criteria; 3 = alternative moderately favorable to sub-criteria; 4 = alternative compares unfavorably to sub-criteria; 5 = alternative compares very unfavorably to sub-criteria)

Table 7-3
Remedial Action Alternatives – Comparative Analysis
Bay Shore MGP Site – OU-1
Bay Shore, New York

Criteria	Sub-Criteria	Rating[1] Alt. 1: Excavate Shallow Source, ISCO, NAPL recovery	Alt. 2: Excavate Deep Source, ISCO, Contain and Cap	Alt. 3: Excavate Deep Source, ISCO, & PRB for Deep Impacts	Alt. 4: Excavate Shallow Source, and Stabilize Deep Impacts	Comparison Statement
Reduction of Toxicity, Mobility, and Volume	Amount of material destroyed or treated	1	5	5	2	All alternatives will result in the removal/destruction/ stabilization of source material. However, a larger volume of soil is removed/stabilized with Alternatives 2 and 3.
	Degree of Toxicity, Mobility, or Volume reduced	1	4	3	4	Alternatives 2 and 3 remove the most volume. Alternatives 2 and 4 control mobility more than Alternative 3.
	Irreversibility	2	2	1	3	Alternatives that require stabilization of the subsurface soils will be the least reversible final remedies.
	Residuals Remaining	2	3	3	3	Alternatives 2 and 3 would remove the largest volume of impacted materials from the Site.
	Score	**6**	**14**	**12**	**12**	
Short-Term Impacts and Effectiveness	Protection of Community during Remedial Action	3	2	2	2	All alternatives require excavation and off-site transport of impacted soils that will potentially impact on the community and will require the implementation of appropriate controls during construction (air monitoring, dust suppression, etc.). The stabilization alternative offers a lower risk due to the decrease in excavation required.
	Environmental Impacts	2	1	1	2	There are no foreseeable adverse environmental impacts for any alternative for subsurface soils.
	Time Required to Meet Remedial Objectives	2	2	2	4	Alternatives 2 and 3 would more rapidly achieve the Remedial Objectives due the smaller excavation volume and decreased dewatering.
	Protection of Workers	3	2	3	2	The stabilization option will reduce the potential worker exposure to subsurface impacts at the site. Appropriate measures to protect worker safety (air monitoring, PPE) would have to be implemented for all alternatives that could result in direct exposure.
	Score	**10**	**7**	**8**	**10**	

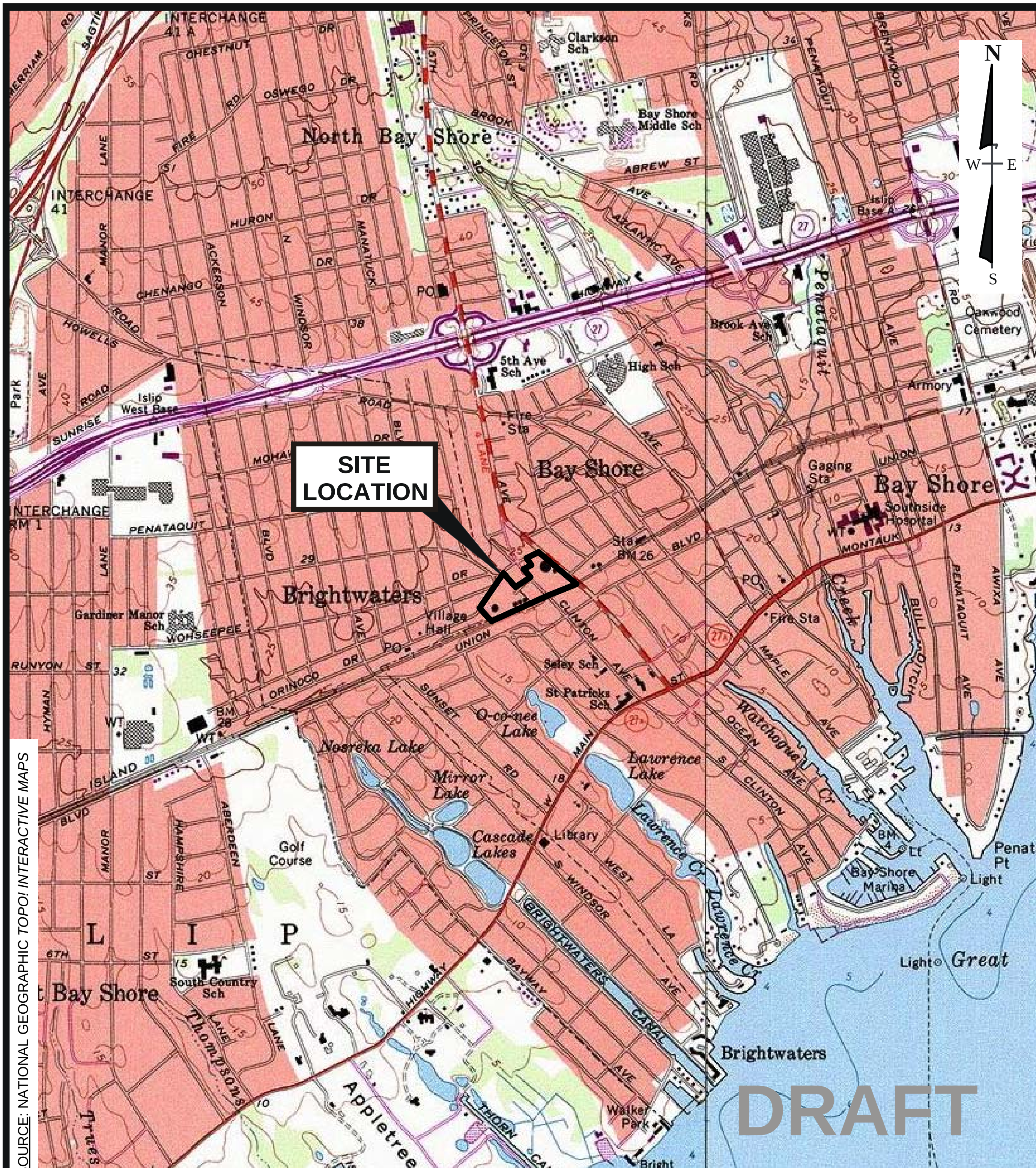
Note:
1. Score is based on a qualitative scale (1 = alternative compares very favorably to sub-criteria; 2 = alternative compares favorably to sub-criteria; 3 = alternative moderately favorable to sub-criteria; 4 = alternative compares unfavorably to sub-criteria; 5 = alternative compares very unfavorably to sub-criteria)

Table 7-3
Remedial Action Alternatives – Comparative Analysis
Bay Shore MGP Site – OU-1
Bay Shore, New York

Criteria	Sub-Criteria	Rating[1] Alt. 1: Excavate Shallow Source, ISCO, NAPL recovery	Alt. 2: Excavate Deep Source, ISCO, Contain and Cap	Alt. 3: Excavate Deep Source, ISCO, & PRB for Deep Impacts	Alt. 4: Excavate Shallow Source, and Stabilize Deep Impacts	Comparison Statement
Implementability	Technical Feasibility	2	2	4	4	All alternatives will employ generally recognized and reliable technologies with similar post remedy monitoring considerations. Alternatives that will require more site time will have a higher risk of equipment failure resulting in remedy delays.
	Administrative Feasibility	2	3	2	3	Alternative 1 will require extensive site work will likely have more coordination related delays. In addition all alternatives that require barrier installation along City streets will require coordination with the City due to its proximity to the streets and may require closure for long periods.
	Availability of Services	2	1	3	4	Although a majority of site work will be completed with conventional construction equipment, Alternative 4 requiring the use of stabilization could have equipment availability related delays.
	Score	**6**	**6**	**9**	**11**	
Cost	Capital Costs	2	4	4	4	Capital costs for construction dewatering and treatment of impacted soils drive the costs of the remedies. Those alternatives with large excavation volumes, disposal volumes, and/or dewatering costs have increased associated capital costs.
	O&M costs	2	4	4	4	All alternatives will require similar post remedy monitoring programs. Alternatives 2 and 3 require more O&M.
	Score	**4**	**8**	**8**	**8**	
Total Score		**34**	**56**	**53**	**55**	

Note:
1. Score is based on a qualitative scale (1 = alternative compares very favorably to sub-criteria; 2 = alternative compares favorably to sub-criteria; 3 = alternative moderately favorable to sub-criteria; 4 = alternative compares unfavorably to sub-criteria; 5 = alternative compares very unfavorably to sub-criteria)

Figures



SOURCE: NATIONAL GEOGRAPHIC *TOPO! INTERACTIVE MAPS*

2000 1000 0 2000 4000

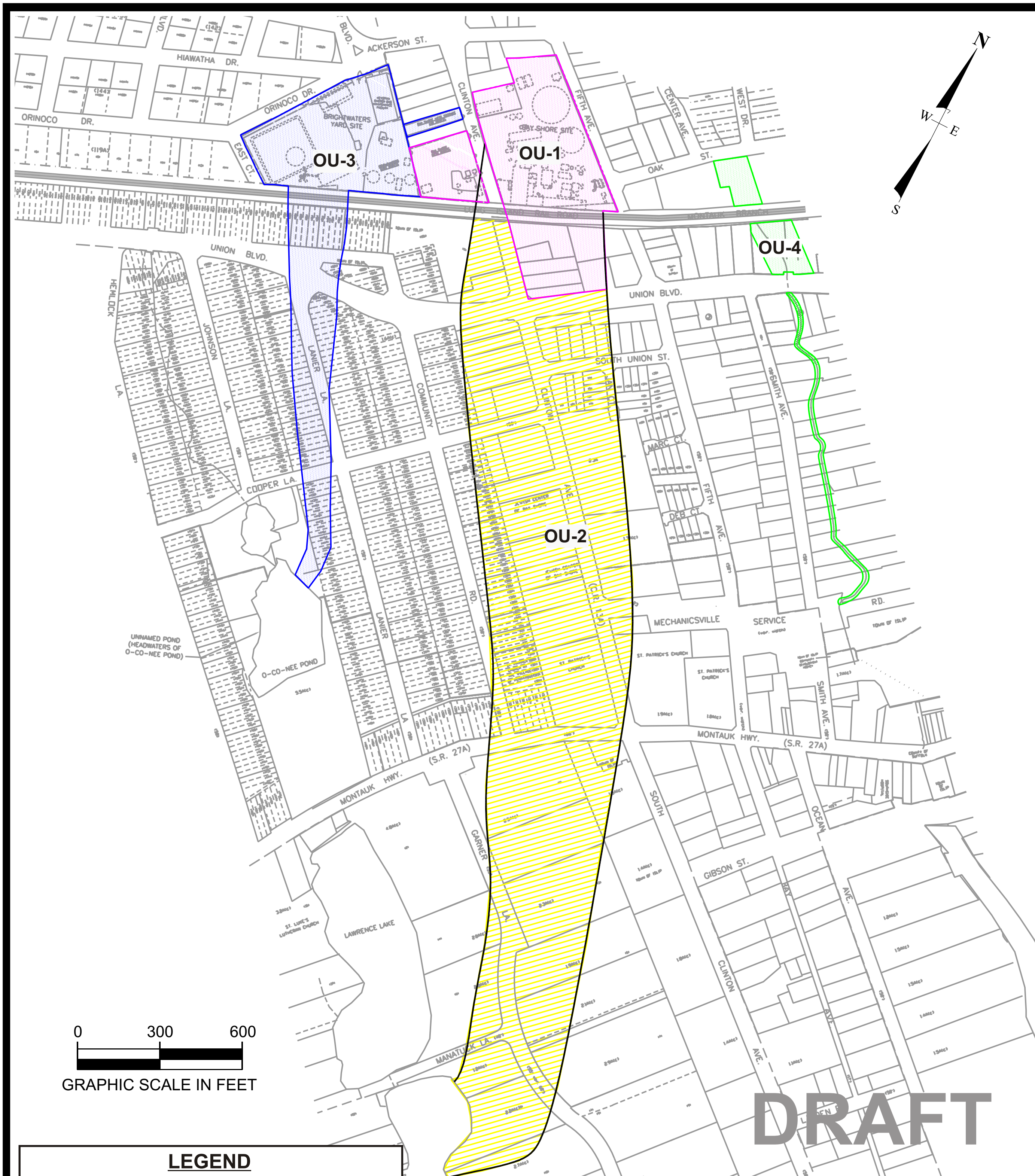
GRAPHIC SCALE IN FEET

GEI Consultants, Inc.

FIGURE 1-1
SITE LOCATION MAP

KEYSPAN ENERGY
BAY SHORE FORMER MGP SITE
BAY SHORE, NEW YORK

GEI\KEYSPAN\BAYSHORE\BAY SHORE-LOC.PPT



LEGEND

- ESTIMATED LIMIT OF BTEX/PAH PLUME BASED ON 100 ug/L TOTAL BTEX AND 100 ug/L TOTAL PAH CONCENTRATION ISOPLETH
- OU-1 BAYSHORE SITE, BAYSHORE WEST PARCEL AND ADJACENT OFF-SITE
- OU-2 BAYSHORE GROUNDWATER PLUME
- OU-3 RIGHTWATERS YARD AND BRIGHTWATERS GROUNDWATER PLUME
- OU-4 WATCHOGUE CREEK/CRUM'S BROOK (CESSPOOL, POND AND CREEK)

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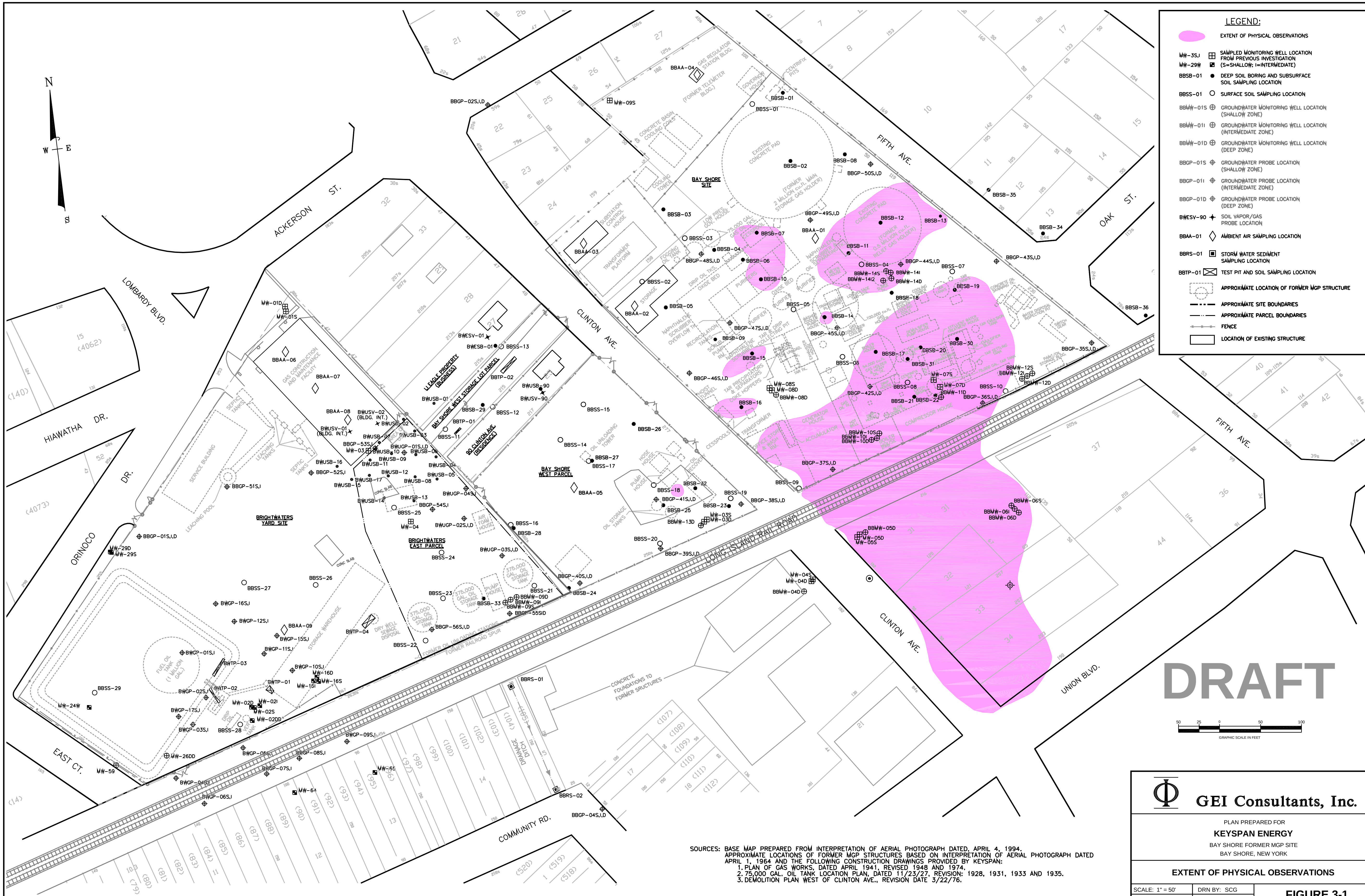
FIGURE 1-2
GEOGRAPHIC BOUNDARIES OF THE OPERABLE UNIT DESIGNATIONS

KEYSPAN
BAY SHORE FORMER MGP SITE
BAY SHORE, NEW YORK

KEYSPAN\BAYSHORE\BAY-OU DES.CDR



SOURCES: BASE MAP PREPARED FROM INTERPRETATION OF AERIAL PHOTOGRAPH DATED, APRIL 4, 1994. APPROXIMATE LOCATIONS OF FORMER MGP STRUCTURES BASED ON INTERPRETATION OF AERIAL PHOTOGRAPH DATED APRIL 1, 1964 AND THE FOLLOWING CONSTRUCTION DRAWINGS PROVIDED BY KEYSPAN:
1. PLAN OF GAS WORKS, DATED APRIL 1941, REVISED 1948 AND 1974.
2. 75,000 GAL. OIL TANK LOCATION PLAN, DATED 11/23/27, REVISION: 1928, 1931, 1933 AND 1935.
3. DEMOLITION PLAN WEST OF CLINTON AVE., REVISION DATE 3/22/76.

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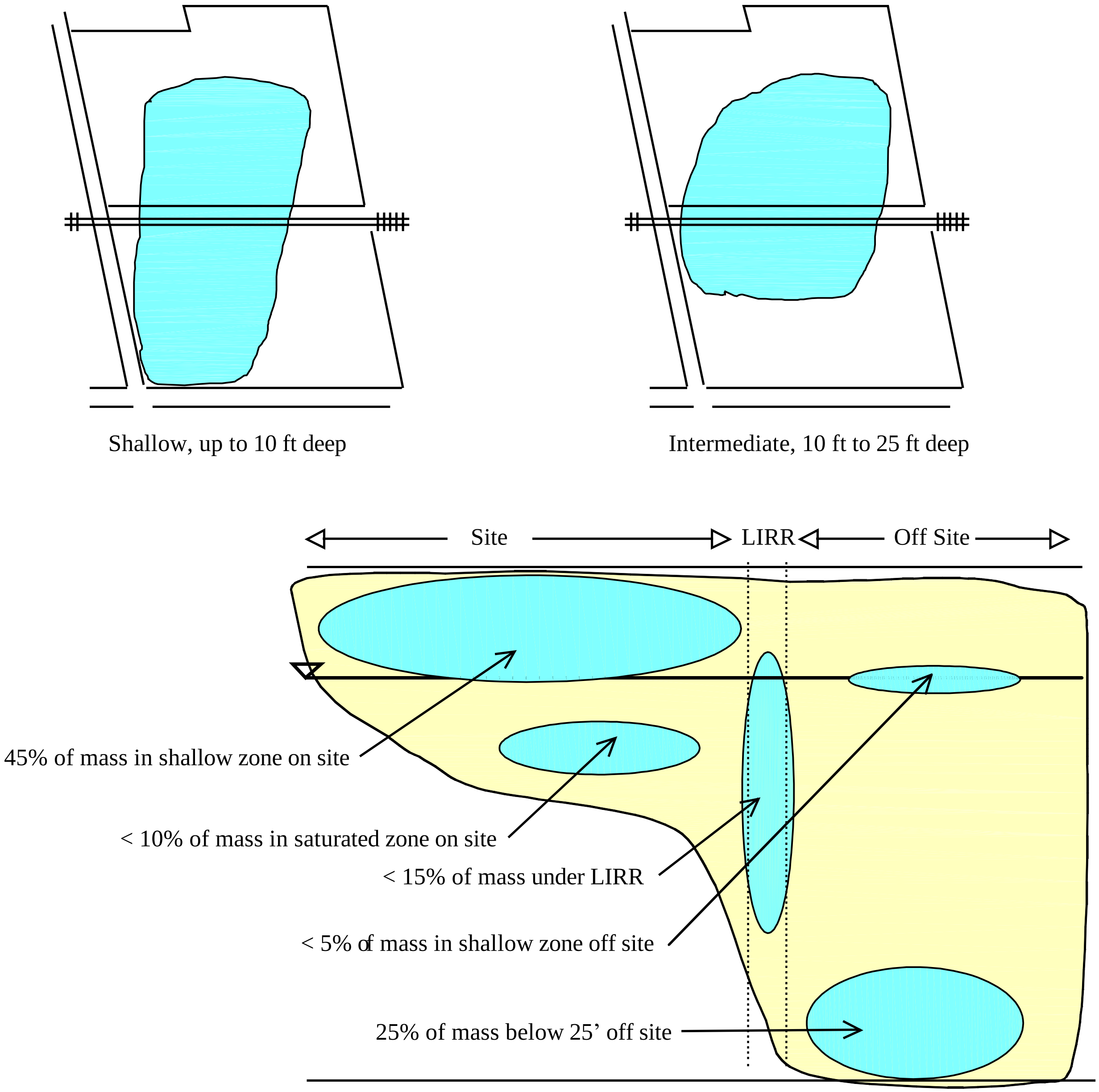
PLAN PREPARED FOR
KEYSPAN ENERGY
BAY SHORE FORMER MGP SITE
BAY SHORE, NEW YORK

EXTENT OF PHYSICAL OBSERVATIONS

SCALE: 1" = 50'	DRN BY: SCG	FIGURE 3-1
DATE: JUNE 2003	982482-3-1402	



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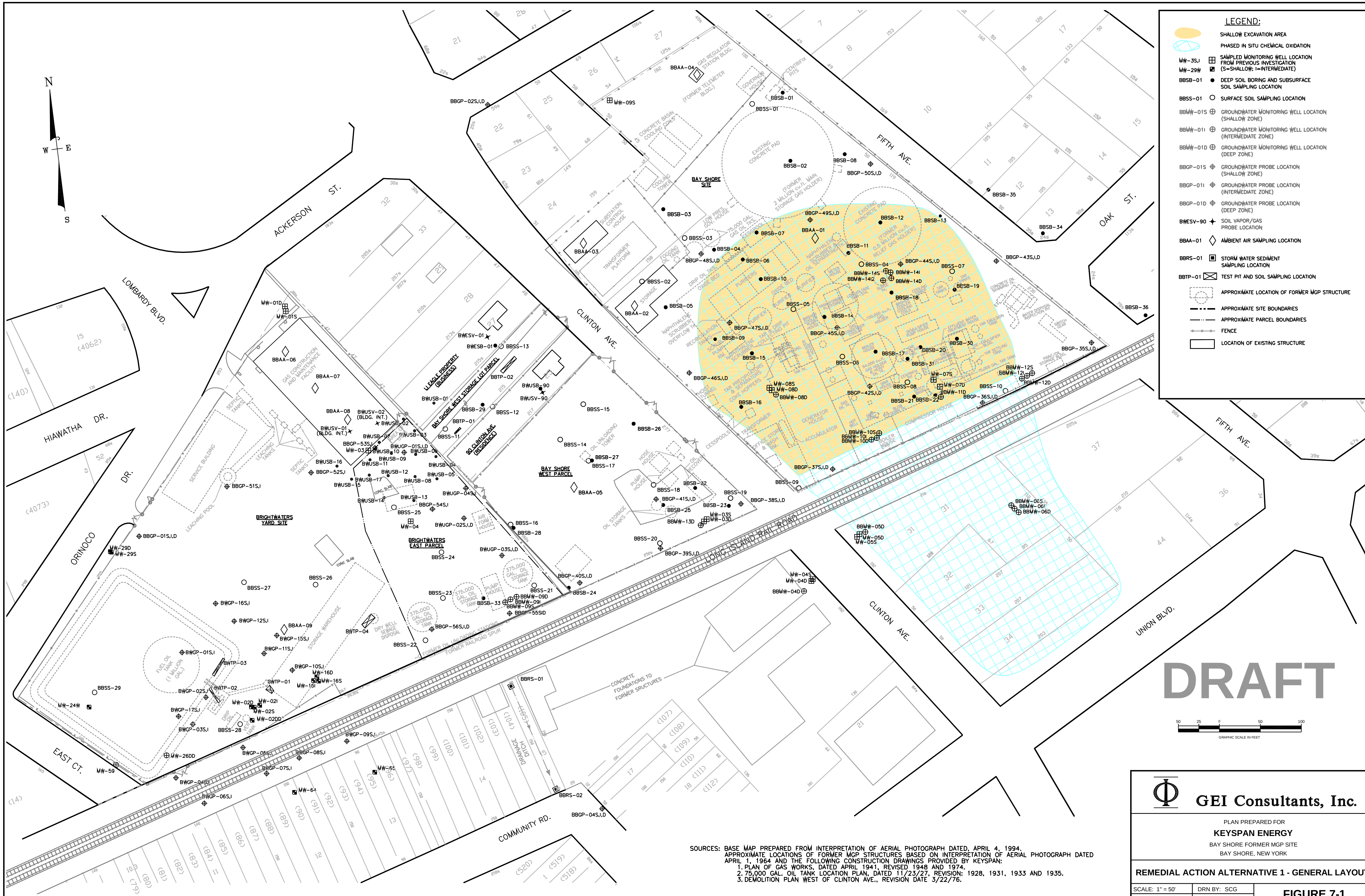
KEYSPAN ENERGY

BAY SHORE FORMER MGP SITE
BAY SHORE, NEW YORK

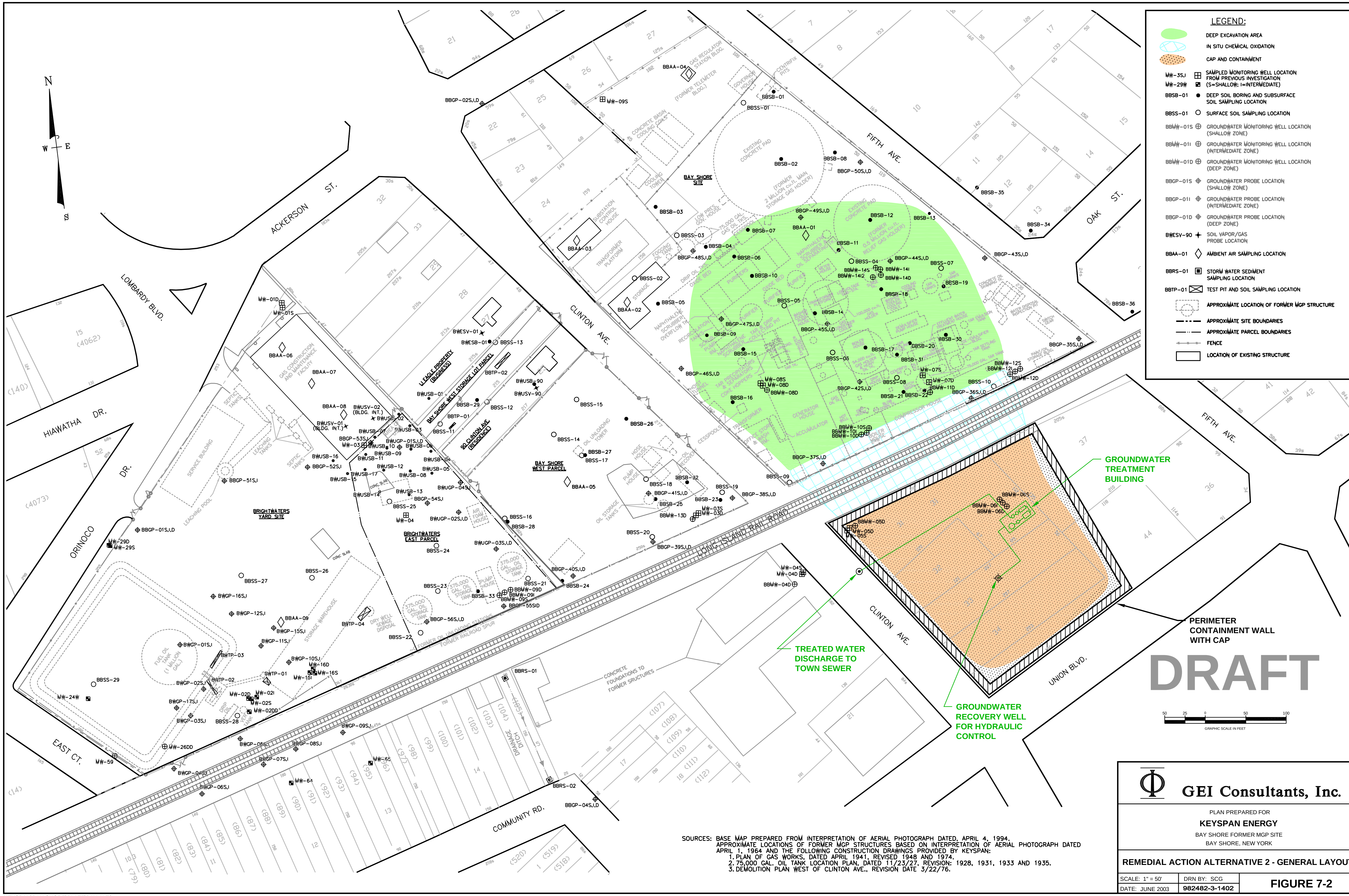
CONCEPTUAL MODEL: DISTRIBUTION OF SOURCE MATERIAL WITHIN OPERABLE UNIT 1

SCALE: NO SCALE	DRN BY: JNG	FIGURE 3-2
DATE: JUNE 2003	982482-3-1402	

GEI\KEYSPAN\BAYSHORE\RAP\BAY-RAP-CONC



KEYSPAN\BAY SHORE\PLATE\BAY-ALT1



LEGEND:
DEEP EXCAVATION AREA
IN SITU CHEMICAL OXIDATION
CAP AND CONTAINMENT
SAMPLED MONITORING WELL LOCATION FROM PREVIOUS INVESTIGATION (S=SHALLOW; I=INTERMEDIATE)
DEEP SOIL BORING AND SUBSURFACE SOIL SAMPLING LOCATION
SURFACE SOIL SAMPLING LOCATION
GROUNDWATER MONITORING WELL LOCATION (SHALLOW ZONE)
GROUNDWATER MONITORING WELL LOCATION (INTERMEDIATE ZONE)
GROUNDWATER MONITORING WELL LOCATION (DEEP ZONE)
GROUNDWATER PROBE LOCATION (SHALLOW ZONE)
GROUNDWATER PROBE LOCATION (INTERMEDIATE ZONE)
GROUNDWATER PROBE LOCATION (DEEP ZONE)
SOIL VAPOR/GAS PROBE LOCATION
AMBIENT AIR SAMPLING LOCATION
STORM WATER SEDIMENT SAMPLING LOCATION
TEST PIT AND SOIL SAMPLING LOCATION
APPROXIMATE LOCATION OF FORMER MGP STRUCTURE
APPROXIMATE SITE BOUNDARIES
APPROXIMATE PARCEL BOUNDARIES
FENCE
LOCATION OF EXISTING STRUCTURE
GROUNDWATER TREATMENT BUILDING
PERIMETER CONTAINMENT WALL WITH CAP
TREATED WATER DISCHARGE TO TOWN SEWER
GROUNDWATER RECOVERY WELL FOR HYDRAULIC CONTROL
DRAFT
ACKERSON ST.
LOMBARDY BLVD.
HIAWATHA DR.
ORINOCO DR.
EAST CT.
CLINTON AVE.
FIFTH AVE.
OAK ST.
UNION BLVD.
COMMUNITY RD.
LONG ISLAND RAIL ROAD
BAY SHORE SITE
BAY SHORE WEST PARCEL
BRIGHTWATERS YARD SITE
BRIGHTWATERS EAST PARCEL
GRAPHIC SCALE IN FEET
SOURCES: BASE MAP PREPARED FROM INTERPRETATION OF AERIAL PHOTOGRAPH DATED, APRIL 4, 1994.
APPROXIMATE LOCATIONS OF FORMER MGP STRUCTURES BASED ON INTERPRETATION OF AERIAL PHOTOGRAPH DATED APRIL 1, 1964 AND THE FOLLOWING CONSTRUCTION DRAWINGS PROVIDED BY KEYSPAN:
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3. DEMOLITION PLAN WEST OF CLINTON AVE., REVISION DATE 3/22/76.
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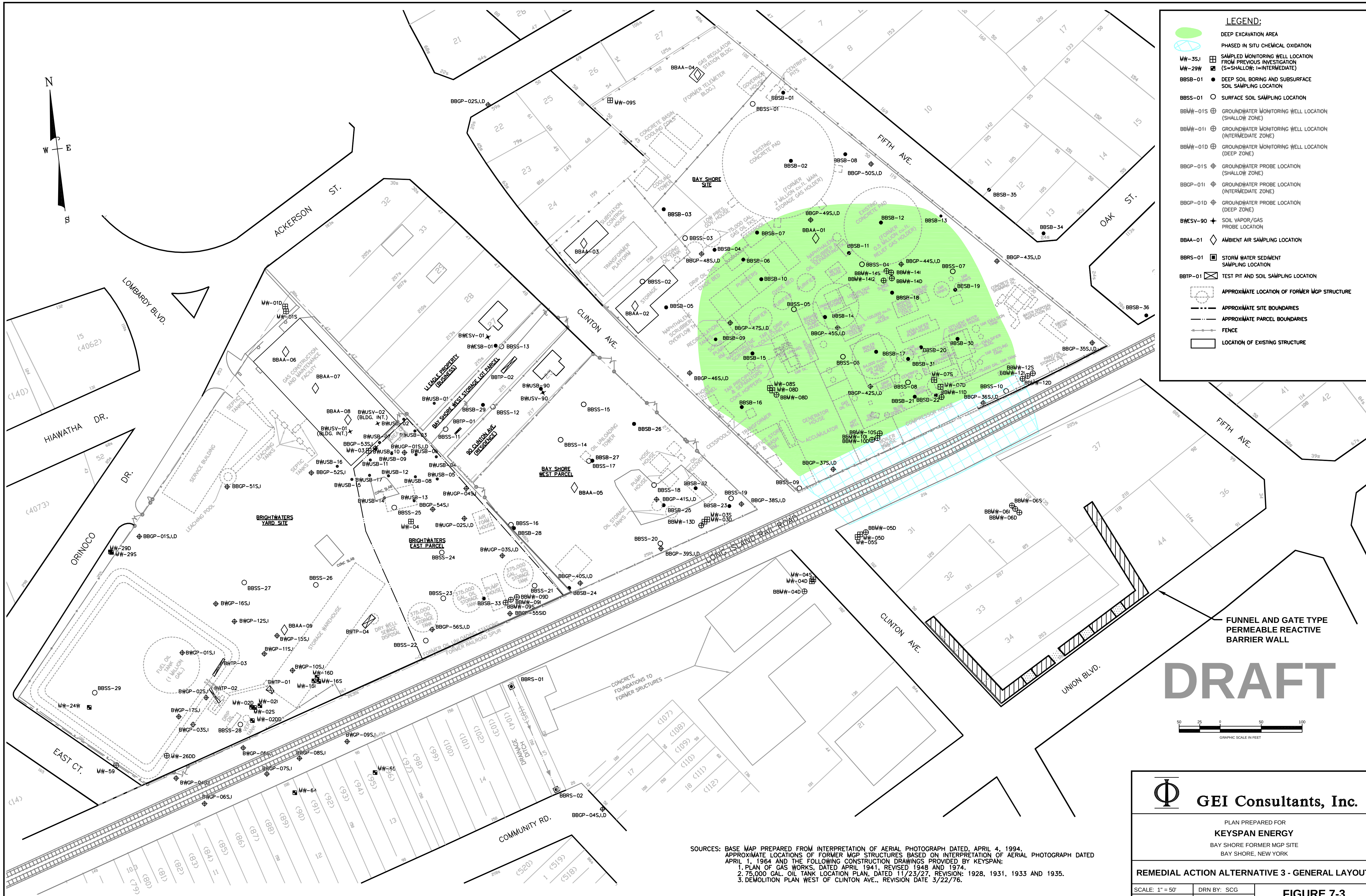
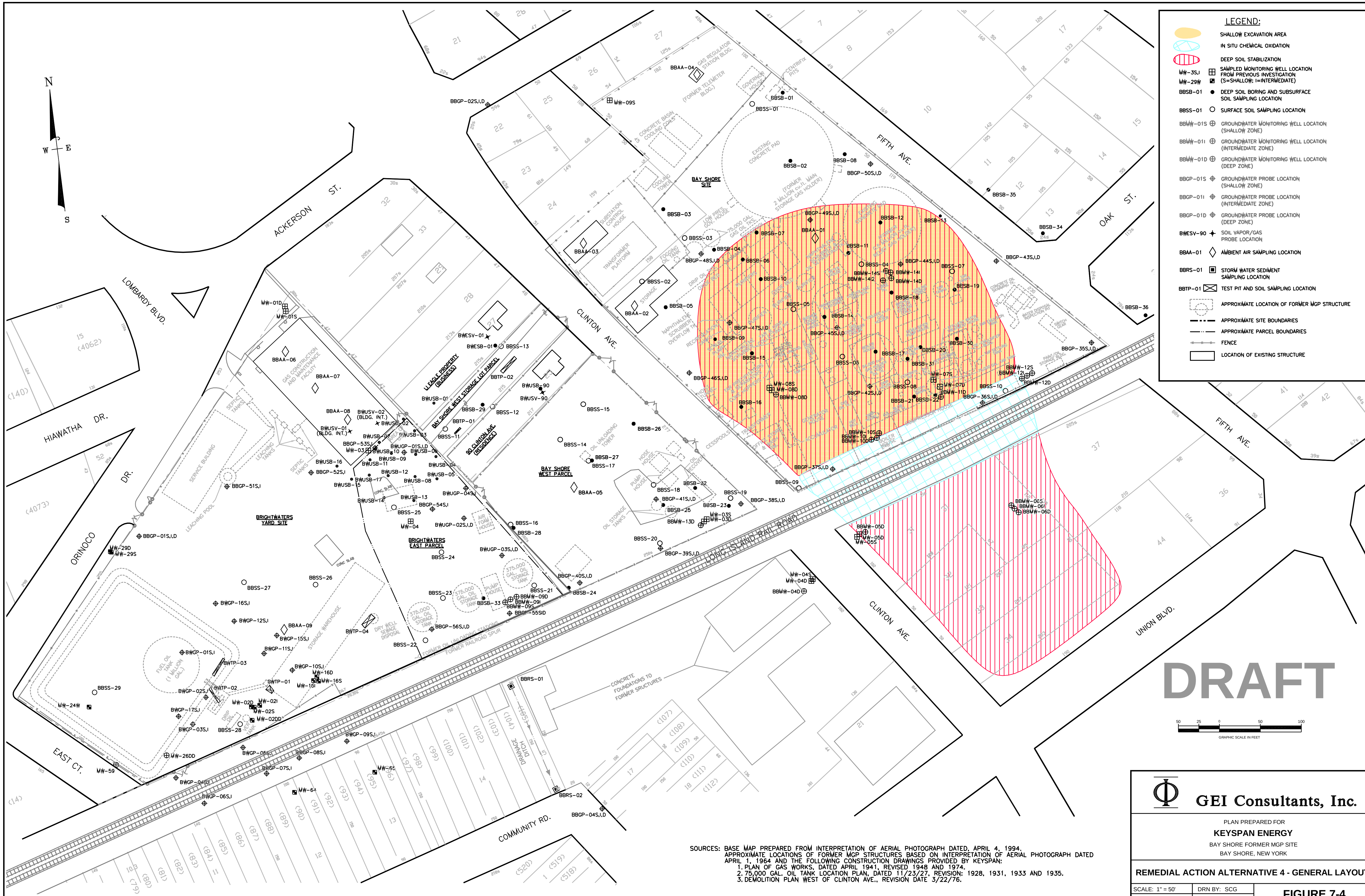
PLAN PREPARED FOR
KEYSPAN ENERGY
BAY SHORE FORMER MGP SITE
BAY SHORE, NEW YORK
REMEDIAL ACTION ALTERNATIVE 2 - GENERAL LAYOUT
SCALE: 1" = 50'
DRN BY: SCG
DATE: JUNE 2003
982482-3-1402
FIGURE 7-2



KEYSPAN\BAY SHORE\PLATE\BAY-ALT3



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BAY SHORE, NEW YORK

REMEDIAL ACTION ALTERNATIVE 4 - GENERAL LAYOUT

SCALE: 1" = 50' | DRN BY: SCG | DATE: JUNE 2003 | 982482-3-1402

FIGURE 7-4

KEYSPAN\BAY SHORE\PLATE\BAY-ALT4

Appendix A

Remedial Alternative Cost Estimates

Table A-1
Detailed Cost Estimate for Remedial Alternative 1
Bay Shore MGP Site - OU-1
Bay Shore, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 1 Excavate - Maximum 8' in Impacted areas of Site, Install - Phased In-Situ Chemical Oxidation and Recover - NAPL where feasible. Quantity	Total Cost
COMMON COST COMPONENTS				
Preconstruction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 500,000	1	$ 500,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 External Issues	Lump Sum	$ 750,000	1	$ 750,000
4 Pre Construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 1,450,000
			% Total Costs	4%
Construction Management				
1 Construction Oversight	Day	$ 1,920	300	$ 576,000
2 Air Monitoring during excavations	Day	$ 960	150	$ 144,000
3 Air Monitoring System	Month	$ 120,000	5	$ 600,000
4 Site Survey (Preconstruction and Post-Remediation)	Acre	$ 5,000	10	$ 50,000
			Subtotal	$ 1,370,000
			% Total Costs	4%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 500,000
2 Site Preparation (fence and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Temporary Offices for excavation period +3 months	Month	$ 3,000	12	$ 36,000
4 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
5 Site Restoration (Landscaping, etc.)	Lump Sum	$ 400,000	1	$ 400,000
			Subtotal	$ 1,011,000
			% Total Costs	3%
REMEDIAL COMPONENTS				
Excavate in Site Area to 8 feet, Install In Situ Chemical Oxidation System to destroy source material below 8 feet at site, LIRR, and off-site areas, Recover NAPL if feasible				
1 Relocate utilities in the excavation area	Lump Sum	$ 100,000	1	$ 100,000
2 Excavation of impacted soils and structures from 0-8 feet	Cubic Yard	$ 25	26,963	$ 674,074
3 In-situ Chemical Oxidation of Source on-site, LIRR and Off-site areas 8 to 50 feet	Cubic Yard	$ 110	152,833	$ 16,811,667
4 NAPL recovery and treatment system - 3 wells, storage, handling system and disposal	Lump Sum	$ 100,000	1	$ 100,000
5 Excavation Sheeting & Support (20 foot depth)	Square Feet	$ 25	5,000	$ 125,000
6 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
7 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	40,444	$ 2,628,889
8 Backfill all excavations	Cubic Yard	$ 30	26,963	$ 808,889
			Subtotal	$ 21,397,519
			% Total Costs	65%
Long Term Monitoring and Maintenance				
1 Periodic Monitoring, Reporting, Disposal and Maintenance	Year	$ 75,000	30	$ 1,152,934
assume I=5%			**Subtotal**	$1,152,934
			% Total Costs	3%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 25,228,519
Total O & M costs				$ 1,152,934
Total Capital and O&M costs without contingency				$ 26,381,452
Contingency (25%)			25%	$ 6,595,363
			TOTAL COST	**$ 32,976,815**

Table A-2
Detailed Cost Estimate for Remedial Alternative 2
Bay Shore MGP Site - OU-1
Bay Shore, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 2 Excavate - 25' in Impacted Source areas in Site Area, Install In-Situ Chemical Oxidation near LIRR and Cap and Contain Off-Site Area	
			Quantity	Total Cost
COMMON COST COMPONENTS				
Preconstruction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 500,000	1	$ 500,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 Pre Construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
4 External Issues	Lump Sum	$ 750,000	1	$ 750,000
			Subtotal	$ 1,450,000
			% Total Costs	3%
Construction Management				
1 Construction Oversight	Day	$ 1,920	450	$ 864,000
2 Air Monitoring during excavations	Day	$ 960	200	$ 192,000
3 Air Monitoring System	Month	$ 120,000	12	$ 1,440,000
3 Site Survey (Preconstruction and Post-Remediation)	Acre	$ 5,000	10	$ 50,000
			Subtotal	$ 2,546,000
			% Total Costs	6%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 500,000
2 Site Preparation (fence and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Temporary Offices for excavation period +3 months	Month	$ 3,000	18	$ 54,000
4 Temporary Utilities	Lump Sum	$ 35,000	1	$ 35,000
5 Site Restoration	Lump Sum	$ 400,000	1	$ 400,000
			Subtotal	$ 1,039,000
			% Total Costs	3%
REMEDIAL COMPONENTS				
Excavation to 25 feet in Site Area and Installing ISCO and Install Cap and Containment cell in Off-site Areas				
1 Relocate power poles and other utilities in the site area	Lump Sum	$ 100,000	1	$ 100,000
2 Excavation of impacted soils and structures from 0-8 feet	Cubic Yard	$ 25	26,963	$ 674,074
3 Excavation of Impacted soil from 8-25	Cubic Yard	$ 15	57,296	$ 859,444
4 On-site Treatment system for water from dewatering operations	350-gpm	$ 1,000,000	1	$ 1,000,000
5 Dewatering Sat. zone from 8-25 (Treatment system O&M and Discharge Costs)	Gallons	$ 0.06	21,040,000	$ 1,262,400
6 In situ Chemical Oxidation of Source at LIRR 8 to 50 feet	Cubic Yard	$ 110	11,667	$ 1,283,333
7 Excavation Sheeting & Support (Braced Sheeting, 60 foot depth)	Square Feet	$ 25	127,200	$ 3,180,000
8 Bracing cost for sheeting	47	$ 15	140,400	$ 2,106,000
9 Containment Wall Sheeting	Square Feet	$ 45	72,100	$ 3,244,500
10 Wastage (25% of wall volume) Handling and disposal	Cubic Yard	$ 50	2,003	$ 100,139
11 Slurry Disposal	Gallons	$ 10	35,000	$ 350,000
12 Hydraulic Control System (2 wells, 4 pumps, piping, treatment and permitting)	Lump Sum	$ 1	300,000	$ 300,000
13 Construction of Surface Cap, Geotextile, Base, Binder, and Wearing Course	Square foot	$ 2	60,000	$ 117,000
14 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
15 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	126,389	$ 8,215,278
16 Backfill all excavations	Cubic Yard	$ 30	84,259	$ 2,527,778
			Subtotal	$ 25,468,946
			% Total Costs	61%
Long Term Monitoring and Maintenance				
1 Pump Repair and Maintenance	Year	$ 15,000	30	$ 230,587
2 Treatment System O & M	Year	$ 75,000	30	$ 1,152,934
3 Monitoring and Reporting	Year	$ 75,000	30	$ 1,152,934
4 Waste Disposal Costs	Year	$ 10,000	30	$ 153,725
assume I=5%			**Subtotal**	$2,690,179
			% Total Costs	6%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 30,503,946
Total O & M costs				$ 2,690,179
Total Capital and O&M costs without contingency				$ 33,194,125
Contingency (25%)			25%	$ 8,298,531
			TOTAL COST	**$ 41,492,657**

Table A-3
Detailed Cost Estimate for Remedial Alternative 3
Bay Shore MGP Site - OU-1
Bay Shore, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 3 Excavate - 25' in Impacted Source areas in Site Area, Install In-Situ Chemical Oxidation near LIRR and Permeable Reactive Barrier for Off-Site Area	
			Quantity	Total Cost
COMMON COST COMPONENTS				
Preconstruction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 500,000	1	$ 500,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 Pre Construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
4 External Issues	Lump Sum	$ 750,000	1	$ 750,000
			Subtotal	$ 1,450,000
			% Total Costs	3%
Construction Management				
1 Construction Oversight	Day	$ 1,920	450	$ 864,000
2 Air Monitoring during excavations	Day	$ 960	200	$ 192,000
3 Air Monitoring System	Month	$ 120,000	12	$ 1,440,000
3 Site Survey (Preconstruction and Post-Remediation)	Acre	$ 5,000	10	$ 50,000
			Subtotal	$ 2,546,000
			% Total Costs	6%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 500,000
2 Site Preparation (fence and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Temporary Offices for excavation period +3 months	Month	$ 3,000	18	$ 54,000
4 Temporary Utilities	Lump Sum	$ 35,000	1	$ 35,000
5 Site Restoration (Landscaping, etc)	Lump Sum	$ 400,000	1	$ 400,000
			Subtotal	$ 1,039,000
			% Total Costs	2%
REMEDIAL COMPONENTS				
Excavation to 25 feet in Site Area and Installing ISCO and Install Permeable Reactive Barrier in Off-site Areas				
1 Relocate power poles and other utilities in the site area.	Lump Sum	$ 100,000	1	$ 100,000
2 Excavation of impacted soils and structures from 0-8 feet	Cubic Yard	$ 25	26,963	$ 674,074
3 Excavation of Impacted soil from 8-25	Cubic Yard	$ 15	57,296	$ 859,444
4 On-site Treatment system for water from dewatering operations	350-gpm	$ 1,000,000	1	$ 1,000,000
5 Dewatering Sat. zone from 8-25 (Treatment system O&M and Discharge Costs)	Gallons	$ 0.06	21,040,000	$ 1,262,400
6 In-situ Chemical Oxidation of Source at LIRR 8 to 50 feet	Cubic Yard	$ 110	11,667	$ 1,283,333
7 Excavation Sheeting & Support (Braced Sheeting, 60 foot depth)	Square Feet	$ 25	127,200	$ 3,180,000
8 Bracing cost for sheeting	Exposed sq. ft	$ 15	140,400	$ 2,106,000
9 Permeable Reactive Barrier Wall Sheeting	Square Feet	$ 45	35,000	$ 1,575,000
10 Wastage (25% of wall volume) Handling and disposal	Cubic Yard	$ 50	972	$ 48,611
11 Slurry Disposal	Gallons	$ 10	15,000	$ 150,000
12 Precast Square Reactive Barrier Structures	Lump Sum	$ 4	800,000	$ 3,200,000
13 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
14 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	126,389	$ 8,215,278
15 Backfill all excavations	Cubic Yard	$ 30	84,259	$ 2,527,778
			Subtotal	$ 26,330,919
			% Total Costs	59%
Long Term Monitoring and Maintenance				
1 PRB Replacement and Maintenance	Year	$ 100,000	30	$ 1,537,245
2 Monitoring & Reporting	Year	$ 75,000	30	$ 1,152,934
3 Waste Disposal Costs	Year	$ 100,000	30	$ 1,537,245
assume I=5%			**Subtotal**	$4,227,424
			% Total Costs	10%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 31,365,919
Total O & M costs				$ 4,227,424
Total Capital and O&M costs without contingency				$ 35,593,343
Contingency (25%)			25%	$ 8,898,336
			TOTAL COST	**$ 44,491,678**

Table A-4
Detailed Cost Estimate for Remedial Alternative 4
Bay Shore MGP Site - OU-1
Bay Shore, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 4 Excavate - Maximum 8' in Impacted areas of Site, Install - In-Situ Chemical Oxidation in Deep zones near LIRR and Stabilize deep zones in Site and Off-site Areas. Quantity	Total Cost
COMMON COST COMPONENTS				
Preconstruction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 500,000	1	$ 500,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 External Issues	Lump Sum	$ 750,000	1	$ 750,000
4 Pre Construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 1,450,000
			% Total Costs	3%
Construction Management				
1 Construction Oversight	Day	$ 1,920	300	$ 576,000
2 Air Monitoring during excavations	Day	$ 960	150	$ 144,000
3 Air Monitoring System	Month	$ 120,000	9	$ 1,080,000
3 Site Survey (Preconstruction and Post-Remediation)	Acre	$ 5,000	10	$ 50,000
			Subtotal	$ 1,850,000
			% Total Costs	4%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 500,000
2 Site Preparation (fence and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Temporary Offices for excavation period +3 months	Month	$ 3,000	12	$ 36,000
4 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
5 Site Restoration	Lump Sum	$ 400,000	1	$ 400,000
			Subtotal	$ 1,011,000
			% Total Costs	2%
REMEDIAL COMPONENTS				
Excavate in Site Area to 8 feet, Install In Situ Chemical Oxidation System to destroy source material at LIRR, and Stabilize Deep Site and Off-site areas				
1 Relocate utilities in the excavation area.	Lump Sum	$ 100,000	1	$ 100,000
2 Demolish existing structures	Lump Sum	$ 100,000	1	$ 100,000
3 Excavation of impacted soils and structures from 0-8 feet	Cubic Yard	$ 25	26,963	$ 674,074
4 In-situ Chemical Oxidation of Source at LIRR 8 to 50 feet	Cubic Yard	$ 110	11,667	$ 1,283,333
5 Stabilization Equipment	Lump Sum	$ 250,000	1	$ 250,000
6 Treatability Study Costs	Lump Sum	$ 15,000	1	$ 15,000
7 Removal of debris in deep zones and clearing - Estimate 5% of volume	Cubic Yard	$ 20	7,058	$ 141,167
8 Soil Treatment (Jet Grouting - Fly Ash, Portland Cement, Bentonite Amendment)	Cubic Yard	$ 200	141,167	$ 28,233,333
9 Additional Spoils and bulky waste	ton	$ 149	10,588	$ 1,577,538
10 Excavation Sheeting & Support (20 foot depth)	Square Feet	$ 25	5,000	$ 125,000
11 Disposal Costs and Hauling of Bulky Waste	ton	$ 149	1,000	$ 149,000
12 Disposal Costs Hauling and Thermal Treatment	ton	$ 65	40,444	$ 2,628,889
13 Backfill all excavations	Cubic Yard	$ 30	26,963	$ 808,889
			Subtotal	$ 36,086,223
			% Total Costs	69%
Long Term Monitoring and Maintenance				
1 Periodic Monitoring, Reporting, Disposal and Maintenance	Year	$ 75,000	30	$ 1,152,934
assume I=5%			**Subtotal**	$1,152,934
			% Total Costs	2%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 40,397,223
Total O & M costs				$ 1,152,934
Total Capital and O&M costs without contingency				$ 41,550,157
Contingency (25%)			25%	$ 10,387,539
			TOTAL COST	**$ 51,937,696**