Feasibility Study

Rockaway Park Former MGP Site
Rockaway Park, New York
NYSDEC Consent Index No. D1-0002-98-11
Site Number 2-41-029

GEI Consultants, Inc.

188 Norwich Avenue
Colchester, Connecticut 06415
(860) 537-0751

SUBMITTED TO

KeySpan Corporation
One MetroTech Center
15th Floor
Brooklyn, NY 11201-3850

July 2004
982482-7-1802

Table of Contents

Tables

Figures

Appendix

Executive Summary

This report presents a Feasibility Study (FS) for the KeySpan Corporation (KeySpan) Rockaway Park Former Manufactured Gas Plant (MGP) Site in Rockaway Park, Queens County, New York (the Site). This report has been prepared in accordance with the Order on Consent, Index No. D1-0002-98-11, (the Order) signed by KeySpan and the New York State Department of Environmental Conservation (NYSDEC). The content and scope of the FS were proposed in the November 1999 *Remedial Investigation/Feasibility Study Work Plan, Rockaway Park Former MGP Site (D&B, 1999).*

In accordance with the Order, the Feasibility Study 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, including *Draft DER-10, Technical Guidance for Site Investigation and Remediation (NYSDEC, 2002).*

The Site is a Class 2 Inactive Hazardous Waste Disposal Site under the New York State environmental conservation law. Under the statute and applicable regulations, the Site must be remediated, to the degree feasible, to pre-release conditions, that is the environmental conditions that are known to have existed before the site was used for an MGP facility in the 1870's. This FS considers remedial options within this statutory and regulatory requirement, which is the remediation goal for the Site. Because this is the remediation goal, the remediation -- including source and contaminated soil removal, containment barriers and other engineered solutions and on-going institutional controls -- would permit any potential re-use of the site, including but not limited to recreational, commercial or residential.

Consistent with the statutory and regulatory prescription, and 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:

- Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.
- Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.
- Remove, to the extent practicable, the source of groundwater contamination.
- Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.
- Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.

- Prevent, to the extent practicable, migration of contaminants that would result in surface water contamination.

In consideration of the site conditions and applicable regulations and guidance, the following remedial alternative, Alternative 3A is recommended for the Site:

- Excavate shallow contamination source areas in the unsaturated zone and off-site thermally treat and dispose of the excavated material;
- Construct vertical subsurface barriers to prevent horizontal migration of NAPL;
- Recover NAPL where it will readily flow into a well;
- Construct an engineered soil cover system across the currently undeveloped portions of the Site, after other remedial actions are completed;
- Implement a long-term groundwater and NAPL monitoring program; and
- Establish and maintain institutional controls to restrict groundwater use on the Site, monitor conditions at the Site, maintain the engineered soil cover system, and manage future ground-intrusive activity.

The estimated cost to implement this remedy is $30,200,000.

1. Purpose

1.1 Introduction

This report presents a Feasibility Study (FS) for the KeySpan Corporation (KeySpan) Rockaway Park Former Manufactured Gas Plant (MGP) Site in Rockaway Park, Queens County, New York (the Site). This report has been prepared in accordance with the Order on Consent, Index No. D1-0002-98-11, (the Order) signed by KeySpan and the New York State Department of Environmental Conservation (NYSDEC). The content and scope of the FS were proposed in the November 1999 *Remedial Investigation/Feasibility Study Work Plan, Rockaway Park Former MGP Site (D&B, 1999).*

The Site is located on the north shore of the Rockaway Peninsula on the south side of Beach Channel Drive, west of Beach 108th Street. Rockaway Freeway borders the site on both the south and west. A site location map is shown on Figure 1-1.

The Site operations began in the late 1870s and continued through 1957. Most of the Site facilities were demolished in 1958. 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 1997 through 2002 have comprehensively delineated these subsurface impacts. Interim Remedial Measures were conducted in early 1999 to locate, cut, drain and plug underground piping associated with former MGP operations and limit potential for off-site migration of MGP-derived waste materials.

The January 2004 *Final Report, Remedial Investigation Rockaway Park Former MGP Site, Rockaway Park, New York (GEI, 2004)* (RI Report) summarizes the findings of all the investigations and remedial actions and recommends further remedial action to eliminate migration pathways and/or eliminate impacts.

1.2 Scope of Feasibility Study

The Order requires KeySpan to "submit a complete Feasibility Study evaluating on-Site and off-Site remedial actions to eliminate, to the maximum extent practicable, all health and environmental hazards and potential hazards associated with disposal of hazardous materials at the site." Further, the Order requires the Feasibility Study to be 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.

An RI/FS Work Plan was submitted by KeySpan in November 1999. In addition to the EPA guidance document and the RI/FS Work Plan, the FS was also prepared in accordance with the *NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites* and *Draft DER-10, Technical Guidance for Site Investigation and Remediation (NYSDEC, 2002)*.

In all areas of significance, the guidance documents and RI/FS Work Plan used in preparing this FS are consistent in their approach and requirements. However, that Work Plan was for a Focused FS, which is a more streamlined screening and evaluation of potential technologies and alternatives than a traditional FS.

The results of this FS will be used for selection of a final remedial alternative for the Site, the preparation of a Record of Decision (ROD) by the NYSDEC, and the preparation of the Remedial Design, as described in the Order on Consent.

An assessment of sediments in Jamaica Bay adjacent to the site is underway and no conclusions have yet been made regarding the need for any remedial action. This FS does not consider any remedial activity associated with the sediments.

The City of New York recently installed a steel sheet pile bulkhead at the northern end of the site. At present, no construction records or engineering reports are available that describe the as-built conditions of this new wall. In this FS, it is assumed that the bulkhead, as constructed, provides sufficient structural support to retain the soil behind it under static loading conditions.

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 *DER-10* Remedy Selection Reporting Requirements 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
- Recommended Remedy

2. Site Description and History

This section presents a summary description of the site, its history, previous investigations and interim remedial measures. Refer to the January 2004 RI Report and the April 2002 RI Report for more complete descriptions of the site and its history.

2.1 Site Description

The former MGP property encompasses approximately 9.8 acres as depicted on Figure 3-1 and currently includes the following:

- An active KeySpan natural gas regulator station location in the southeast portion of the property
- A vacated three-story office building and a one-story former workshop building in the north central portion of the property

A paved driveway extends from the gate on Beach 108th Street to the office building area. Equipment storage areas are located in the north-central portion of the site and are covered with gravel. The active substation is also covered with gravel and is locked and surrounded by fencing. The remaining portion of the property is primarily covered with vegetation, grass, or soil. The entire property is enclosed by fencing and is secure from public access.

The site definition once included an area now occupied by an active Long Island Power Authority (LIPA) substation. The area occupied by the substation is no longer considered part of the former MGP and requires no further investigation or remediation.

Surrounding properties include:

- North: Beach Channel Drive. North of Beach Channel Drive is a New York City owned 0.6 acre strip of land (Bulkhead Area), and then Jamaica Bay.
- East: Beach 108th Street. East of Beach 108th Street is a New York City sewage treatment plant.
- South: Rockaway Freeway. South of Rockaway Freeway are Metropolitan Transportation Authority (MTA) subway tracks and an MTA yard. South of the tracks and yard are private residences.

- West: Rockaway Freeway. West of Rockaway Freeway are several auto service and retail businesses.

2.2 Site History

A summary of the Rockaway MGP history based on D&B's Remedial Investigation Report is presented below. A more detailed discussion of the MGP history is presented in D&B's Report.

The Rockaway MGP began operations in the late 1870s. The plant was operated by Rockaway Electric Light Co., Town of Hempstead Gas & Electric Company and later the Queensboro Gas and Electric Company from the late 1870s to 1926. In 1926, Queensboro Gas and Electric Company became a subsidiary of the Long Island Lighting Company (LILCO) in 1926. LILCO operated the plant from 1926 to approximately 1958 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.

In 1894, the plant consisted of two gas holders, generator, purifiers and scrubbers. The records indicate the MGP operated carbureted water gas and coal carbonization processes during early gas production. After 1905, the carbureted water gas process was the only process used during gas production. In 1912, the MGP expanded to the north and east and a portion of the southern property boundary was located beneath the present Rockaway Freeway. The plant now included a half-million cubic foot gas holder, several oxide tanks, generator and boiler buildings, engine room, several oil tanks, and a condenser.

The plant expanded in the mid-1920s to a strip of land to the north of the then existing plant. This land was created when Jamaica Bay was filled in during Beach Channel Drive Construction. In 1933, the plant figuration now included several additional structures that could allow increase gasification, tar and oil separation and storage, and coke and gas storage. These structures included a 2-million cubic foot gas holder, drip oil tanks, skimming basin, condensers, oxide enclosure, generator ash storage bin, tar separator, tar settling and drying tanks, and tar de-emulsifier. The MGP plant ceased operations circa 1958 when most of the facilities were demolished.

Five industrial supply wells were also located on the former MGP property. A mixture of clay, liquid mud, and cement were used to abandon these wells. Three of the wells were abandoned in the 1930s and the abandonment dates of the other two wells are not known.

Several drain pipes were identified by D & B on plant construction drawings. These lines appeared to lead to Jamaica Bay. The pipes were identified as saltwater drain lines, an oil line, and a sump drain line.

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 January 2004 RI Report, which presents a conceptual site model and comprehensive depiction of the nature and extent of contamination at the Site. The January 2004 RI Report also includes Qualitative Human Health and Ecological Risk Assessments. This section summarizes the findings presented in the January 2004 RI Report that are relevant to developing and analyzing remedial alternatives. Refer to the January 2004 RI Report 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 Rockaway former MGP suggests the presence of four separate source areas of tar-saturated material in the subsurface. The four source areas are:

- The vicinity of the former tar separators and holders in the Former Gas Works Area
- The vicinity of the former skimming basin in the Former Gas Works Area
- The depositional tar saturated material in the Former Electric Substation Area
- The former drip tanks located in the Former 2 Million CF Holder and Drip Tank Area

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 is depicted on Figure 3-1. Figure 3-1 is a depth-integrated composite of the broadest observed lateral extent of visually identifiable NAPL related impacts, including tar saturation, and blebs, sheens and staining.

Free tar has not been observed within the bulkhead area. The NAPL-related impacts observed there are limited to sheens, blebs and staining. The supplemental sediment investigation currently underway will provide a more complete assessment of the existence of or potential for significant migration of NAPL to Jamaica Bay. Preliminary findings from this investigation indicate that there is presently no significant migration of free-phase NAPL into Jamaica Bay.

3.2.2 Surface Soil

PAHs, cyanide, and metals 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. 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.

3.2.3 Subsurface Soil

BTEX, PAHs, and metals, were identified as COCs in subsurface soil to depths of approximately 120 feet below grade in the area of the former gas works. 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. Metals in soil are also anticipated to be relatively persistent.

3.2.4 Groundwater

BTEX, PAHs, and cyanide have been identified as COCs in groundwater. The significant tidal influence on site groundwater has had a significant effect on limiting the migration of dissolved phase impacts off-site. The inversion that occurs at high tide creates ebb and flow of groundwater over the impacted areas and limits the migration of dissolved phase impacts off site. This effect decreases with depth and has limited effect on the deep groundwater zone.

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 equals 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 the well clusters located near the bulkhead area. It is possible that the dissolved phase plume has reached Jamaica Bay; however, if it has, volatilization and dilution would minimize or eliminate any impacts.

3.3 Qualitative Human Exposure Assessment

A qualitative human exposure assessment is included in the January 2004 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
- Ingestion, dermal contact and vapor inhalation of groundwater

Refer to the exposure assessment in the 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 2004 RI Report. The analysis concluded that the Site is having no significant impact on fish and/or wildlife resources. The bulkhead is assumed to be stable, and will prevent the migration of soil into Jamaica Bay via wave erosion. 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, PAH, and cyanide.

4. Remedial Goals and Remedial Action Objectives

4.1 Remedial Goals

The NYSDEC's Remedy Selection guidance puts forth the following remedial goals:

- Restoration of the site to pre-disposal/pre-release conditions, to the extent feasible and authorized by law.
- At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.
- 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.

Restoration to pre-disposal/pre-release conditions will be extremely difficult, if not infeasible at the site, and may present considerable risks to the community. This lack of feasibility is primarily attributable to the great depths to which some contaminants have migrated downward in the over 130 years since they may have first been released at the site. The risk to the community related to concerns that soil and material removal at these great depths could have serious adverse consequences to the geological structures supporting this area of the Rockaway Peninsula. However, a remedial alternative to achieve this level of remediation will be analyzed in this FS to provide a sense of the scale of such an undertaking and the detrimental effects such an alternative would have on the local community.

The Site Remedial Goals, therefore, are (1) eliminate or mitigate all significant threats to public health and the environment; and, (2) remove or eliminate, to the extent feasible, identifiable sources of contamination, regardless of intended use of the site or presumed risk. These goals establish the site-specific Standards, Criteria and Guidelines (SCGs) for determining the success of the final remedy, in accordance with TAGM 4030 and NYSDEC's determination of what is feasible for the site.

4.2 Remedial Action Objectives

Remedial Action Objectives (RAOs) are medium-specific 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:

GROUNDWATER

- Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.
- Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.
- Remove, to the extent practicable, the source of groundwater contamination.

SOIL

- Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.
- Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.
- Prevent, to the extent practicable, migration of contaminants that would result in surface water contamination of Jamaica Bay.

In this FS it is assumed that the last RAO has been achieved by the new bulkhead and the planned Interim Remedial Measure to remove MGP-related materials from the unsaturated zone soil within the bulkhead area. Accordingly, the remedial alternatives considered in the FS do address not address this RAO.

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.

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. Given the high hydraulic conductivity, high water table, and tidal influence of Jamaica Bay at the Site, and the vertical extent of contamination, excavation of all impacted soils and NAPL is infeasible. Soil or source materials removed by excavation would need to be further remediated by disposal or treatment.

5.1.3 Treatment

Treatment is applicable to the soil, groundwater, 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, groundwater, and soil at the site. For NAPL and groundwater, 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 cover systems 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. Specific institutional controls would be tailored to the remedy chosen and the ultimate re-use of the property. More information on typical institutional controls that may be appropriate for the site is provided below.

Access control measures, such as fencing, security and general monitoring of the site, help to prevent someone who is not knowledgeable of site conditions from performing ground-intrusive work and creating a potential exposure pathway to remaining contaminants.

A deed restriction and/or environmental easement is a legal instrument that would serve to notify any potential future property owners of the environmental conditions and any use restrictions placed on the site, such as a prohibition on using groundwater beneath the site.

Procedures for managing ground-intrusive work include establishing a protocol for overseeing worker and public health and safety, having a plan for managing any contaminated soil or groundwater removed during the work, and establishing a mechanism, such as including the site area in the “one-call” system, to notify people who may otherwise be unaware of conditions at the site prior to conducting ground-intrusive work.

An important component of any institutional control program is ongoing monitoring of the effectiveness of the controls. This includes annually certifying that the controls are in place and are effective.

6. Identification and Screening of Technologies

6.1 Introduction

This section evaluates potentially applicable technologies to determine those that can be effectively implemented at the Site to achieve the remediation goals. Information presented in the Remedial Investigation on contaminant types, distribution and location and on the Site's physical characteristics are used to screen the technologies to determine which can be successfully implemented and which will not be feasible.

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, highly permeable soil, and tidal influence on groundwater; the deep vertical extent of contamination; 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 6 to 8 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. When vertical barriers can be constructed to tie into this stratum, groundwater control within an excavation can be more efficiently maintained. At the Site, no strata of low permeability soils was found to exist within at least 150 feet of the ground surface which was investigated. Regional data identifies approximately 980 feet of unconsolidated deposits overlying bedrock. Also, historic supply wells were documented on the site to extend to these depths confirming the regional data is accurate for the immediate Site area. Therefore, dewatering issues will be significant components in any remedy involving excavation below the water table.

The relatively high hydraulic conductivity of the Site soils also poses issues for potential in-situ technologies, such as chemical oxidation, that require control of the subsurface environment. The tidal influence also poses challenges to in-situ technologies and containment technologies that involve hydraulic control.

The remedial investigations have shown that contamination extends vertically to over 125 feet within some portions of the site. This is well beyond the reach of conventional and even most specialized construction equipment. However, as stated in the January 2004 RI Report, the contamination present at such depths poses little risk. For this FS, contamination below a depth of 45 feet is not considered to pose significant risk. This depth is chosen to approximate the maximum depth of the adjacent channel in Jamaica Bay to the north of the Site. Horizontal migration at this depth will be well below the bottom of Jamaica Bay, and upward vertical migration of contaminants is extremely unlikely. Preliminary findings from the sediment investigation indicate that there is presently no significant migration of free-phase NAPL into Jamaica Bay. The potential for migration exists, however, and this FS will consider alternatives that prevent potential migration over a range of depths.

The City of New York recently installed a steel sheet pile bulkhead at the northern end of the site. At present, no construction records or engineering reports are available that describe the as-built conditions of this new wall. The wall is constructed of regular steel sheeting, is not watertight, and cannot be considered an effective barrier to movement of NAPL or water. The relic structures immediately behind the steel sheet piles preclude the placement of grout or other sealants immediately behind the steel sheets. The stability of the bulkhead under the dynamic conditions that would accompany construction of an additional barrier within the bulkhead area is unknown. Such construction, such as driving sheets, jet grouting, or deep excavation under slurry, would alter the soil conditions behind the wall and increase the risk of bulkhead wall failure.

The gas regulator station and its appurtenances are expected to remain on the site indefinitely. While no specific future use for the balance 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 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 and disposal/recycle
- Engineered cover system
- NAPL recovery
- Vertical containment (various construction methods)
- In-situ stabilization
- Monitoring
- 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 list of site-wide remedial alternatives. These alternatives are then described in detail and then evaluated against seven criteria as specified in DER-10. Lastly, a comparative analysis of the alternatives is presented.

7.2 Remedial Alternatives

In consideration of technological, Site, medium, and contaminant-specific factors, the following alternatives were developed for consideration and evaluation. To achieve the NYSDEC's overall remedial goal: "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," alternatives 2 through 5 include excavation and off-site low temperature thermal desorption and disposal/recycle of contaminant source material in the unsaturated zone and removal of relic MGP structures. Off-site treated soils will not return to the Site. Imported clean backfill will be utilized. Alternatives 1 through 4 also include construction of an engineered soil cover system to limit disturbance of and prevent exposure to impacted soils. Alternatives 1 through 4 also include long-term monitoring plans and institutional controls to limit subsurface disturbance and, when disturbance is necessary, to have a protocol in place to control potential exposure to contaminants. Alternatives 1 through 4 also include passive NAPL recovery. The alternatives are:

1) Engineered soil cover system, passive NAPL recovery, groundwater monitoring, and institutional controls.
2) Unsaturated zone excavation of source material, engineered soil cover system, passive NAPL recovery, groundwater monitoring, and institutional controls.
2a) Unsaturated zone excavation of source material, saturated zone excavation of source material to 18' below grade, engineered soil cover system, passive NAPL recovery, groundwater monitoring, and institutional controls.
3) Unsaturated zone excavation of source material, engineered soil cover system, passive NAPL recovery, subsurface NAPL migration barrier on the north side of the main site extending to 50 feet in depth, groundwater monitoring, and institutional controls.

3a) Unsaturated zone excavation of source material, engineered soil cover system, passive NAPL recovery, an on-site subsurface NAPL migration barrier on the north side of the site extending 50 feet in depth along the length of the site with a 120 feet deep section in the central portion, an offsite subsurface NAPL migration barrier within the bulkhead area extending 70 feet in depth running along the central portion of the site, groundwater monitoring, and institutional controls.
4) Unsaturated zone excavation of source material, engineered soil cover system, passive NAPL recovery, an on-site subsurface NAPL migration barrier on the north side of the site extending 50 feet in depth across the length of the site with a 120 feet deep section in the central portion, in-situ stabilization of subsurface soils to 70 feet beneath Beach Channel Drive and the bulkhead area in the central portion of the site, groundwater monitoring, and institutional controls.
5) Restore site to pre-release conditions.
6) No action.

7.3 Description of Alternatives

Each of the eight 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.

7.3.1 Alternative 1: Engineered soil cover system/NAPL Recovery

This alternative includes construction of an engineered soil cover system over undeveloped portions of the site and the bulkhead area, a long-term groundwater monitoring program, a NAPL monitoring and passive recovery program, and institutional controls to manage future subsurface disturbance and resultant potential exposures. Eventual new construction on site would include engineered vapor management. With respect to the guidance, the alternative is described as follows:

- **Size and configuration:** Figure 7-1 illustrates the conceptual plans of this alternative. The entire area of the Site will be disturbed to some degree to construct the cover system. Construction of the engineered soil cover system will include 2 feet of clean soil with a geotextile construction barrier underlying the soil. NAPL will be collected via extraction wells. The locations and screen intervals of the extraction wells will be determined during the remedial design phase. The collection system will be passive in nature, collecting on a periodic basis only free NAPL which readily enters an extraction well (i.e. no mobility enhancers would be injected into the subsurface to increase the rate and quantity of extraction).

- **Time for remediation**: The estimated time to complete all construction-related remediation activities is 6 months pending access to non-owned properties. Monitoring, NAPL recovery, and maintenance of institutional controls will continue indefinitely.

- **Spatial requirements:** The Site can readily accommodate the space required for equipment and material storage, access, logistics, and operations. When the cover system is constructed on the bulkhead parcel, it will likely be necessary to temporarily close lanes of Beach Channel Drive to traffic for several weeks to accommodate construction equipment and control access to the areas undergoing remediation.

- **Options for disposal:** Options for disposal of excavated and removed materials are readily available.

- **Permit requirements:** No significant technical permit requirements are anticipated that would limit the effectiveness or implementability of this alternative.

- **Limitations:** Access to the bulkhead parcel may affect the schedule for remedial activities in this area. Temporary lane closures of Beach Channel Drive, a main thoroughfare for the peninsula of Rockaway, will be necessary to implement this alternative.

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

7.3.2 Alternative 2: Engineered soil cover system/Shallow Source Excavation (8')/NAPL Recovery

This alternative includes construction of an engineered soil cover system over undeveloped portions of the site and the bulkhead area, excavation of contaminant source material and former MGP structures in the unsaturated zone (approximately 8' below grade), a long-term groundwater monitoring program, a NAPL monitoring and passive recovery program, and institutional controls to manage future subsurface disturbance and resultant potential exposures. Eventual new construction on site would include engineered vapor management. If holder foundations or other former MGP structures that may contain source material extend into the saturated zone, excavations will be deepened as necessary to inspect and/or remove the full depth of the structure. With respect to the guidance, the alternative is described as follows:

- **Size and configuration:** Figure 7-2 illustrates the conceptual plans of this alternative. The entire area of the Site will be disturbed to some degree to construct the cover system. Construction of the engineered soil cover system across the site will include 2 feet of clean soil with a geotextile construction barrier underlying the soil. Excavation of the impacted unsaturated zone and former MGP structures will occur over approximately 230,000 square feet of Site area. NAPL will be collected via extraction wells. The locations and screen intervals of the extraction wells will be determined during the remedial design phase. The collection system will be passive in nature, collecting on a periodic basis only free NAPL which readily enters an extraction well (i.e., no mobility enhancers would be injected into the subsurface to increase the rate and quantity of extraction).

- **Time for remediation:** The estimated time to complete all construction-related remediation activities is one year pending access to non-owned properties. Monitoring, NAPL recovery 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. When excavation is performed adjacent to Beach Channel Drive, it will likely be necessary to temporarily close lanes to traffic for several weeks to accommodate construction equipment and control access to the areas undergoing remediation.

- **Options for disposal:** Options for disposal of excavated and removed materials are readily available.

- **Permit requirements:** No significant technical permit requirements are anticipated that would limit the effectiveness or implementability of this alternative.

- **Limitations:** The actual extent of source material and volume of residual NAPL in relic structures represent the greatest areas of uncertainty in this alternative. Temporary lane closures of Beach Channel Drive, a main thoroughfare for the peninsula of Rockaway, will be necessary to implement this alternative.

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

7.3.3 Alternative 2A: Engineered soil cover system/Shallow Source Excavation (18')/NAPL Recovery

This alternative includes construction of an engineered soil cover system over undeveloped portions of the site and the bulkhead area, excavation of contaminant source material and former MGP structures in the unsaturated zone (approximately 8' below grade), excavation of shallow contaminant source material in the saturated zone (to approximately 18' below grade), a long-term groundwater monitoring program, a NAPL monitoring and passive recovery program, and institutional controls to manage future subsurface disturbance and resultant potential exposures. Eventual new construction on site would include engineered vapor management. If holder foundations or other former MGP structures that may contain source material extend beyond 18 feet below grade, excavations will be deepened as necessary to inspect and/or remove the full depth of the structure. With respect to the guidance, the alternative is described as follows:

- **Size and configuration:** Figure 7-2A illustrates the conceptual plans of this alternative. The entire area of the Site will be disturbed to some degree to construct the cover system. Construction of the engineered soil cover system across the site will include 2 feet of clean soil with a geotextile construction barrier underlying the soil. Excavation of the impacted unsaturated zone and former MGP structures will occur over approximately 230,000 square feet of Site area. Excavation of the upper 10' of the impacted saturated zone will occur over approximately 125,000 square feet of Site area. Sheeting will be used for saturated zone excavations and some dewatering may be necessary. NAPL will be collected via extraction wells. The locations and screen intervals of the extraction wells will be determined during the remedial design phase. The collection system will be passive in nature, collecting on a periodic basis only free NAPL which readily enters an extraction well (i.e. no mobility enhancers would be injected into the subsurface to increase the rate and quantity of extraction).

- **Time for remediation:** The estimated time to complete all construction-related remediation activities is 1.5 years pending access to non-owned properties. Monitoring, NAPL recovery, 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. When excavation is performed adjacent to Beach Channel Drive, it will likely be necessary to temporarily close portions of the road to traffic for several weeks to accommodate construction equipment and control access to the areas undergoing remediation.

- **Options for disposal:** Options for disposal of excavated solid materials are readily available. Options for disposal of dewatering system effluent could be limited, given the high volumes that would be generated. It may not be feasible to transport and dispose of such large volumes of liquid waste off-site. Liquid wastes may have to be treated on-site and discharged locally.

- **Permit requirements:** Technical permit requirements associated with treatment and disposal of dewatering system discharge could be significant and may affect the implementability of this alternative.

- **Limitations:** The actual extent of source material and volume of residual NAPL in relic structures represent the greatest areas of uncertainty in this alternative. Further analysis of dewatering and earth support requirements may identify technical or cost barriers to feasibility. Compared to Alternative 2, the additional amount of source material removed may not provide any significant additional risk reduction. Temporary lane closures of Beach Channel Drive, a main thoroughfare for the peninsula of Rockaway, will be necessary to implement this alternative.

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

7.3.4 Alternative 3: Engineered soil cover system/Shallow Source Excavation (8')/On-site NAPL Migration Barrier (50')/NAPL Recovery

This alternative includes construction of an engineered soil cover system over undeveloped portions of the site and the bulkhead area, excavation of contaminant source material and former MGP structures in the unsaturated zone (approximately 8' below grade), a long-term groundwater monitoring program, a subsurface NAPL migration barrier installed to a depth of 50' below grade, a NAPL monitoring and passive recovery program, and institutional controls to manage future subsurface disturbance and resultant potential exposures. Eventual new construction on site would include engineered vapor management. If holder foundations or other former MGP structures that may contain source material extend into the saturated zone, excavations will be deepened as necessary to inspect and/or remove the full depth of the structure. 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 area of the Site will be disturbed to some degree to construct the cover system. Construction of the engineered soil cover system across the site will include 2 feet of clean soil with a geotextile construction barrier underlying the soil. Excavation of the entire impacted unsaturated zone will occur over approximately 230,000 square feet of Site area. A subsurface NAPL migration barrier will be installed on the north side of the main site extending 50' in depth below grade to prevent potential NAPL migration northward. The exact location and configuration of the migration barrier and recommended method of construction will be determined during the remedial design phase. For development and costing of the alternative, a soil-bentonite wall installed with a hydraulic excavator is assumed. NAPL will be collected via extraction wells. The locations and screen intervals of the extraction wells will be determined during the remedial design phase; at a minimum, a series of wells will be located within the barrier. The collection system will be passive in nature, collecting on a periodic basis only free NAPL which readily enters an extraction well (i.e. no mobility enhancers would be injected into the subsurface to increase the rate and quantity of extraction).

- **Time for remediation:** The estimated time to complete all construction-related remediation activities is 2 years pending access to non-owned properties. Monitoring, NAPL recovery, 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. When work is performed adjacent to Beach Channel Drive, it will likely be necessary to temporarily close lanes to traffic for several weeks to accommodate construction equipment and control access to the areas undergoing remediation.

- **Options for disposal:** Options for disposal of excavated and removed materials are readily available.

- **Permit requirements:** No significant technical permit requirements are anticipated that would limit the effectiveness or implementability of this alternative.

- **Limitations:** The actual extent of source material and volume of residual NAPL in relic structures represent the greatest areas of uncertainty in this alternative. Continuity, compatibility, permanence, and alteration of groundwater hydraulics are issues to be addressed for the NAPL migration barrier. Temporary lane closures of Beach Channel Drive, a main thoroughfare for the peninsula of Rockaway, will be necessary to implement this alternative.

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

7.3.5 Alternative 3A: Engineered soil cover system/Shallow Source Excavation (8')/On-site NAPL Migration Barrier (50' and 120')/Off-site NAPL Migration Barrier (70')/NAPL Recovery

This alternative includes construction of an engineered soil cover system over undeveloped portions of the site and the bulkhead area, excavation of contaminant source material and former MGP structures in the unsaturated zone (approximately 8' below grade), a long-term groundwater monitoring program, an on-site subsurface NAPL migration barrier installed on the north side of the site extending 50 feet in depth across the length of the site with a 120 feet deep section in the central portion, an offsite NAPL migration barrier immediately south of the bulkhead extending 70 feet in depth along running along the central portion of the site, a NAPL monitoring and passive recovery program, and institutional controls to manage future subsurface disturbance and resultant potential exposures. Eventual new construction on site would include engineered vapor management. If holder foundations or other former MGP structures that may contain source material extend into the saturated zone, excavations will be deepened as necessary to inspect and/or remove the full depth of the structure. With respect to the guidance, the alternative is described as follows:

- **Size and configuration:** Figure 7-3A illustrates the conceptual plans of this alternative. The entire area of the Site will be disturbed to some degree to construct the cover system. Construction of the engineered soil cover system across the site will include 2 feet of clean soil with a geotextile construction barrier underlying the soil. Excavation of the entire impacted unsaturated zone and former MGP structures will occur over approximately 230,000 square feet of Site area. An on-site subsurface NAPL migration barrier will be installed on the north side of the main site extending to 50' in depth across the length of the site with a 120' deep section in the central portion to prevent potential NAPL migration northward. An offsite subsurface NAPL migration barrier will be installed within the bulkhead area along the central portion of the site and extending 70 feet in depth also to prevent northward NAPL migration. The exact location and configuration of the migration barriers, and recommended method(s) of construction will be determined during the remedial design phase. For development and costing of the alternative, a jet-grout wall is assumed for the 120 feet deep section of wall, and soil-bentonite walls installed with a hydraulic excavator are assumed for the 50 and 70 feet deep wall portions. NAPL will be collected via extraction wells. The locations and screen intervals of the extraction wells will be determined during the remedial design phase; at a minimum, a series of wells will be located south of the on-site and off-site barriers. The collection system will be passive in nature, collecting on a periodic basis only free NAPL which readily enters an extraction well (i.e., no mobility enhancers would be injected into the subsurface to increase the rate and quantity of extraction).

- **Time for remediation:** The estimated time to complete all construction-related remediation activities is 2.5 years pending access to non-owned properties. Monitoring, NAPL recovery, 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. When work is performed adjacent to Beach Channel Drive, it will likely be necessary to temporarily close lanes to traffic for several months to accommodate construction equipment and control access to the areas undergoing remediation.

- **Options for disposal:** Options for disposal of excavated and removed materials are readily available.

- **Permit requirements:** No significant technical permit requirements are anticipated that would limit the effectiveness or implementability of this alternative.

- **Limitations:** The actual extent of source material and volume of residual NAPL in relic structures represent the greatest areas of uncertainty in this alternative. Continuity, compatibility, permanence, and alteration of groundwater hydraulics are issues to be addressed for the NAPL migration barriers. The additional depth of the barrier compared to that proposed in Alternative 3 may not provide significant additional prevention of NAPL migration. Construction of the barrier within the bulkhead area may affect the stability of the existing bulkhead. Temporary lane closures of Beach Channel Drive, a main thoroughfare for the peninsula of Rockaway, will be necessary to implement this alternative.

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

7.3.6 Alternative 4: Engineered soil cover system/Shallow Source Excavation (8')/On-site NAPL Migration Barrier (50' and 120')/NAPL Recovery/In-situ Stabilization

This alternative includes construction of an engineered soil cover system over undeveloped areas of the site and the bulkhead area, excavation of contaminant source material and former MGP structures in the unsaturated zone (approximately 8' below grade), a long-term groundwater monitoring program, an on-site subsurface NAPL migration barrier installed on the north side of the site extending 50 feet in depth across the length of the site with a 120 feet deep section in the central portion, a NAPL monitoring and passive recovery program, in-situ stabilization of source material in zones located beneath Beach Channel Drive and the bulkhead area, and institutional controls to manage future subsurface disturbance and resultant potential exposures. Eventual new construction on site would include engineered vapor management. If holder foundations or other former MGP structures that may contain source material extend into the saturated zone, excavations will be deepened as necessary to inspect and/or remove the full depth of the structure. With respect to the guidance, the alternative is described as follows:

- **Size and configuration:** Figure 7-4 illustrates the conceptual plans of this alternative. The entire area of the Site will be disturbed to some degree to construct the cover system. Construction of the engineered soil cover system across the site will include 2 feet of clean soil with a geotextile construction barrier underlying the soil. Excavation of the entire impacted unsaturated zone and former MGP structures will occur over approximately 230,000 square feet of Site area. An on-site subsurface NAPL migration barrier will be installed on the north side of the main site extending to 50’ in depth across the length of the site with a 120’ deep section in the central portion to prevent potential NAPL migration northward. The exact location and configuration of the migration barrier, and recommended method of construction will be determined during the remedial design phase. For development and costing of the alternative, a jet-grout wall is assumed for the 120 feet deep section of wall, and soil-bentonite walls installed with a hydraulic excavator are assumed for the 50 feet deep wall portions. NAPL will be collected via extraction wells. The locations and screened intervals of the extraction wells will be determined during the remedial design phase; at a minimum, a series of wells will be located behind the barrier. The collection system will be passive in nature, collecting on a periodic basis only free NAPL which readily enters an extraction well (i.e., no mobility enhancers would be injected into the subsurface to increase the rate and quantity of extraction). The in-situ stabilization will take place along a portion of Beach Channel Drive and the bulkhead area centered on the site to a depth of approximately 70 feet. The details of a full-scale implementation of this technology for Beach Channel Drive and the bulkhead area would be developed after completion of a bench scale study and field pilot test.

- **Time for remediation:** The estimated time to complete all construction-related remediation activities is 2.5 years pending access to non-owned properties. Monitoring, NAPL recovery, 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. When work is performed in and adjacent to Beach Channel Drive, it will likely be necessary to temporarily close all lanes to traffic for several months to accommodate construction equipment and control access to the areas undergoing remediation and restoration after in-situ stabilization.

- **Options for disposal:** Options for disposal of excavated and removed materials are readily available.

- **Permit requirements:** No significant technical permit requirements are anticipated that would limit the effectiveness or implementability of this alternative.

- **Limitations:** The actual extent of source material and volume of residual NAPL in relic structures represent the greatest areas of uncertainty in this alternative. Continuity, compatibility, permanence, and alteration of groundwater hydraulics are issues to be addressed for the NAPL migration barrier and the in-situ stabilization. The effectiveness of stabilization at the bench and field scale will need to be demonstrated in a laboratory and by a pilot study at the site, respectively. Stabilization of soil within the bulkhead area may affect the stability of the existing bulkhead. Short-term closure of Beach Channel Drive, a main thoroughfare for the peninsula of Rockaway, will be necessary to implement this alternative.

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

7.3.7 Alternative 5: Restore to Pre-release Conditions

This alternative includes the removal via excavation of all impacted material associated with the Site, and construction of an engineered soil cover system across the entire site and the bulkhead area. With respect to the guidance, the alternative is described as follows:

- **Size and configuration:** Figure 7-5 illustrates the conceptual plans of this alternative. The majority of the Site will be disturbed for excavation activities. Removal activities will consist of excavating: the former gasworks area to a depth of approximately 120 feet below grade over an area of approximately 152,000 square feet; the former skimming basin area, a portion of Beach Channel Drive, and a portion of the bulkhead area to an approximate depth of 70’ below grade over an approximate area of 90,000 square feet; the former substation area to an approximate depth of 90 feet below grade over an approximate area of 79,000 square feet; and the former 2,000,000 cubic feet holder and drip tank area to an approximate depth of 30 feet below grade over an approximate area of 52,000 square feet for a combined total excavation volume of approximately 1.2 million cubic yards for offsite transport and thermal treatment.

- **Time for remediation:** The estimated time to complete all construction-related remediation activities is 4.5 years pending access to non-owned properties. 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. When work is performed along and adjacent to Beach Channel Drive, it will be necessary to temporarily close lanes to traffic for several months to accommodate construction equipment and control access to the areas undergoing remediation.

- **Options for disposal:** Options for disposal of this high volume of excavated and removed materials are limited. Regional facilities may not be able to handle the throughput required. It would not be feasible to transport and dispose of such large volumes of liquid waste off-site. Liquid wastes would have to be treated on-site and discharged locally.
- **Permit requirements:** Technical permit requirements associated with the alternative are substantial, particularly the design and construction of adequate earth support and the treatment and disposal of dewatering system effluent.

- **Limitations:** This alternative will have significant negative impacts on traffic in the community. Disposal of excavated soils and delivery of backfill material and supplies will require a substantial quantity of transport vehicle traffic into, through, and out of the town of Rockaway Park over limited access routes for the peninsula for a period of 4-5 years. Dewatering and earth support considerations have the greatest degrees of uncertainty in this alternative. More detailed analysis of the alternative would likely identify many technical and cost barriers to its implementability. Temporary lane closures of Beach Channel Drive, a main thoroughfare for the peninsula of Rockaway, will be necessary to implement this alternative.

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

7.3.8 Alternative 6: No Action

This alternative includes 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:** Institutional controls would include deed restricting the use of all parcels impacted by Site former MGP operations to ensure developers or users do not disturb contamination remaining at the Site, developing a Site-specific Health and Safety Plan, and implementing a long-term natural attenuation monitoring plan.

- **Time for remediation:** Not applicable.

- **Spatial requirements:** Not applicable.

- **Options for disposal:** Not applicable.

- **Permit requirements:** No significant technical permit requirements are anticipated.

- **Limitations:** Exposure to contaminants will be reduced/eliminated, but contaminants can still migrate offsite to properties that may not have institutional controls. Natural attenuation will be monitored long-term.

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

7.4 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:

7.4.1 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.

7.4.2 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.

7.4.3 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

7.4.4 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.

7.4.5 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.

7.4.6 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.

7.4.7 Cost

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

7.5 Evaluation of Alternatives

7.5.1 Alternative 1: Engineered Soil Cover System/NAPL Recovery

- ***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 on the surface and replacing the top two feet of soil with an engineered soil cover system to prevent exposure through contact. Institutional controls will also be established to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.* Affected groundwater beneath the Site is not currently used for water supply and institutional controls will prevent its use in the future. Incidental contact during construction would be managed via worker health and safety plans.

  - *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* This alternative would provide some NAPL migration prevention by recovering flowable NAPL from wells.

  - *Remove, to the extent practicable, the source of groundwater contamination.* NAPL recovery and the excavation of shallow material for construction of the engineered soil cover system will remove a portion of the source, which contributes to groundwater contamination.

  - *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* Proper maintenance of the cover system and institutional controls will achieve this objective.

  - *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* Future construction on the site would include engineered vapor management systems to achieve this objective. The engineered soil cover system will also minimize exposure to contaminants volatilizing from contaminants in soils beneath the cover.

- ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

- *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative eliminates or mitigates all significant threats.

- *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.* With the exception of that required to construct the cover system, no contaminant source material is removed.

- ***Long-Term Effectiveness and Permanence.*** There will be no significant threats, exposure pathways, or risks to the community and the environment from the remaining contamination. Maintenance of a site cover system is straightforward and readily achievable. The RAOs can continue to be met in the future by maintaining the cover system and the institutional controls.

- ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption and disposal/recycle of the excavated surface materials will reduce toxicity, and volume to some extent, but the majority of contamination will remain at depth and will be potentially mobile. The passive recovery of NAPL will also reduce the toxicity and volume of source material.

- ***Short-Term Effectiveness.*** The alternative can be readily implemented, and little to no short-term impacts are expected.

- ***Implementability.*** The alternative is technically implementable. The technologies are available commercially from multiple sources.

- ***Cost.*** The estimated cost is $11.3 million and is summarized in Table 7-1 and Table A-1.

7.5.2 Alternative 2: Engineered Soil Cover System/Shallow Source Excavation (8')/NAPL Recovery

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing source material, constructing an engineered soil cover system over the site, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

- *Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.* Affected groundwater beneath the Site is not currently used for water supply and institutional controls will prevent its use in the future. Incidental contact during construction would be managed via worker health and safety plans.

- *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* This alternative would provide some NAPL migration prevention by recovering flowable NAPL from wells.

- *Remove, to the extent practicable, the source of groundwater contamination.* Excavation of the unsaturated zone source material and former MGP structures will remove, to the extent practicable, the source of groundwater contamination. NAPL recovery will also aid in removing source material, which contributes to groundwater contamination.

- *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* The cover system, excavation, and institutional controls will achieve this objective.

- *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* The removal of unsaturated zone source material, site cover system, engineered vapor management, and institutional controls will achieve this objective.

▪ ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

  - *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative eliminates or mitigates all significant threats.

  - *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.* Contaminant source areas are removed, to the extent feasible.

▪ ***Long-Term Effectiveness and Permanence.*** There will be no significant threats, exposure pathways, or risks to the community and the environment from the remaining contamination. The proposed institutional controls are readily implementable. Maintenance of a site cover system is straightforward and readily achievable. The RAOs can continue to be met in the future by maintaining the cover system and the institutional controls.

- ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption and disposal/recycle of the excavated materials will reduce toxicity, mobility and volume significantly. The passive recovery of NAPL will also reduce the toxicity and volume of source material.

- ***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, suppression of fugitive dust, 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.

- ***Cost.*** The estimated cost is $24.3 million and is summarized in Table 7-1 and Table A-2.

7.5.3 Alternative 2A: Engineered Soil Cover System/Shallow Source Excavation (18')/NAPL Recovery

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing source material, constructing an engineered soil cover system over the site, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.* Affected groundwater beneath the Site is not currently used for water supply and institutional controls will prevent its use in the future. Incidental contact during construction would be managed via worker health and safety plans.

  - *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* This alternative would provide some NAPL migration prevention by recovering flowable NAPL from wells and removing some NAPL via excavation.

- *Remove, to the extent practicable, the source of groundwater contamination.* Excavation of shallow source material and former MGP structures and NAPL recovery will remove, to the extent practicable, the source of groundwater contamination.

- *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* The cover system, excavation, and institutional controls will achieve this objective.

- *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* The removal of shallow source material, site cover system, engineered vapor management, and institutional controls will achieve this objective.

▪ ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

- *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative eliminates or mitigates all significant threats.

- *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.* Contaminant source areas are removed, to the extent feasible; however, further analysis of dewatering and earth support requirements for excavation into the saturated zone may identify technical or cost barriers to feasibility.

▪ ***Long-Term Effectiveness and Permanence.*** The magnitude of the remaining risks is small. The proposed institutional controls are readily implementable. Maintenance of a site cover system is straightforward and readily achievable. The RAOs can continue to be met in the future by maintaining the cover system and the institutional controls.

▪ ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption and disposal/recycle of the excavated materials will reduce toxicity, mobility and volume significantly. The passive recovery of NAPL will also reduce the toxicity and volume of source material.

- ***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, suppression of fugitive dust, perimeter air monitoring, and implementation of health and safety and community awareness plans.

- ***Implementability.*** The alternative is technically implementable, although the deeper excavation will present challenges in earth support and dewatering due to lack of a subsurface confining layer and limited options for handling of dewatering system effluent. The technologies are available commercially from multiple sources. These limitations, together with the additional cost and relatively little added benefit, may make this alternative technically impracticable.

- ***Cost.*** The estimated cost is $54.4 million and is summarized in Table 7-1 and Table A-2a.

7.5.4 Alternative 3: Engineered Soil Cover System/Shallow Source Excavation (8')/NAPL Migration Barrier (50')/NAPL Recovery

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing source material, constructing an engineered soil cover system over the site, preventing migration of mobile NAPL, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.* Affected groundwater beneath the Site is not currently used for water supply and institutional controls will prevent its use in the future. Incidental contact during construction would be managed via worker health and safety plans.

  - *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* Source removal, NAPL recovery, and the NAPL migration barrier will prevent NAPL migration.

  - *Remove, to the extent practicable, the source of groundwater contamination.* Excavation of the unsaturated zone source material and former MGP structures and NAPL recovery will remove, to the extent practicable, the source of groundwater contamination.

- *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* The cover system, excavation, and institutional controls will achieve this objective.

- *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* Exposure to impacted soils are prevented by removing surface soils and constructing an engineered soil cover system over the Site, removing shallow source material, using engineered vapor management in new construction, and by establishing institutional controls to prevent exposures to contaminants remaining in deeper soils.

▪ ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

  - *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative eliminates or mitigates all significant threats.

  - *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.* Contaminant source areas are removed, to the extent feasible.

▪ ***Long-Term Effectiveness and Permanence.*** There will be no significant threats, exposure pathways, or risks to the community and the environment from the remaining contamination. The proposed institutional controls are readily implementable. Maintenance of a site cover system is straightforward and readily achievable. The RAOs can continue to be met in the future by maintaining the cover system and the institutional controls.

▪ ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption and disposal/recycle of the excavated materials will reduce toxicity, mobility and volume significantly. The subsurface NAPL migration barrier reduces the mobility of saturated zone source materials. The passive recovery of NAPL will also reduce the toxicity and volume of source material.

▪ ***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, suppression of fugitive dust, 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.

- ***Cost.*** The estimated cost is $27.9 million and is summarized in Table 7-1 and Table A-3.

7.5.5 Alternative 3A: Engineered Soil Cover System/Shallow Source Excavation (8')/On-site NAPL Migration Barrier (50' and 120')/Off-site NAPL Migration Barrier (70')/NAPL Recovery

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing source material, constructing an engineered soil cover system over the site, preventing migration of mobile NAPL, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.* Affected groundwater beneath the Site is not currently used for water supply and institutional controls will prevent its use in the future. Incidental contact during construction would be managed via worker health and safety plans.

  - *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* Source removal, NAPL recovery, and the NAPL migration barriers will prevent NAPL migration. The deeper barrier may not provide significantly more protection than the 50–foot barrier.

  - *Remove, to the extent practicable, the source of groundwater contamination.* Excavation of the unsaturated zone source material and former MGP structures and NAPL recovery will remove, to the extent practicable, the source of groundwater contamination.

  - *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* The cover system, excavation, and institutional controls will achieve this objective.

- *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* The removal of unsaturated zone source material, site cover system, engineered vapor management, and institutional controls will achieve this objective.

- ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

  - *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative eliminates or mitigates all significant threats.

  - *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.* Contaminant source areas are removed, to the extent feasible.

- ***Long-Term Effectiveness and Permanence.*** There will be no significant threats, exposure pathways, or risks to the community and the environment from the remaining contamination. The proposed institutional controls are readily implementable. Maintenance of a site cover system is straightforward and readily achievable. The RAOs can continue to be met in the future by maintaining the cover system and the institutional controls.

- ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption and disposal/recycle of the excavated materials will reduce toxicity, mobility and volume significantly. The subsurface NAPL migration barrier reduces the mobility of saturated zone source materials and hence its toxicity. The passive recovery of NAPL will also reduce the toxicity and volume of source material.

- ***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, suppression of fugitive dust, 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.

- ***Cost.*** The estimated cost is $30.2 million and is summarized in Table 7-1 and Table A-3a.

7.5.6 Alternative 4: Engineered Soil Cover System/Shallow Source Excavation (8')/On-site NAPL Migration Barrier (50' and 120')/NAPL Recovery/In-situ Stabilization

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing source material, stabilizing/immobilizing source material in saturated zones along Beach Channel Drive and the bulkhead area, constructing an engineered soil cover system over the site, preventing migration of mobile NAPL, and establishing institutional controls to manage future potential exposures.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater.* Affected groundwater beneath the Site is not currently used for water supply and institutional controls will prevent its use in the future. Incidental contact during construction would be managed via worker health and safety plans.

  - *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* Source removal, source stabilization/immobilization, NAPL recovery, and the NAPL migration barrier will prevent NAPL migration.

  - *Remove, to the extent practicable, the source of groundwater contamination.* Excavation of the unsaturated zone source material and former MGP structures and NAPL recovery will remove, to the extent practicable, the source of groundwater contamination.

  - *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* The cover system, excavation, stabilization, and institutional controls will achieve this objective.

  - *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* The removal of unsaturated zone source material, site cover system, stabilization, engineered vapor management, and institutional controls will achieve this objective.

- ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

  - *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative eliminates or mitigates all significant threats.

  - *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.* Contaminant source areas are removed, to the extent feasible.

- ***Long-Term Effectiveness and Permanence.*** There will be no significant threats, exposure pathways, or risks to the community and the environment from the remaining contamination. The proposed institutional controls are readily implementable. Maintenance of a site cover system is straightforward and readily achievable. The RAOs can continue to be met in the future by maintaining the cover system and the institutional controls.
- ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption and disposal/recycle of the excavated materials will reduce toxicity, mobility and volume significantly. The subsurface NAPL migration barrier reduces the mobility of saturated zone source materials and hence its toxicity. The passive recovery of NAPL will also reduce the toxicity and volume of source material. In-situ stabilization will reduce contaminant mobility of offsite source material.

- ***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, suppression of fugitive dust, 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 stabilization technology has been proven at similar sites. Bench scale and pilot testing will be required to develop a full-scale program for the Site.

- ***Cost.*** The estimated cost is $47.3 million and is summarized in Table 7-1 and Table A-4.

7.5.7 Alternative 5: Restore to Pre-release Conditions

- ***Overall Protection of Public Health and the Environment.*** The alternative eliminates or effectively controls the potential exposure pathways by removing all MGP impacts.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, contact with, or inhalation of volatiles from contaminated groundwater.* All source material will be removed during excavation activities, leaving nothing to contribute to the contamination of groundwater.

  - *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* All NAPL within the site boundaries would be removed.

  - *Remove, to the extent practicable, the source of groundwater contamination.* All sources will be removed during excavation and dewatering activities.

  - *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* All contaminated soil will be removed.

  - *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* All impacted soils will be removed via excavation.

- ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

  - *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative eliminates or mitigates all significant threats.

  - *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.* Contaminant source areas are removed, but dewatering and earth support requirements for excavation into the saturated zone at depth will not be feasible as previously detailed in section 5.1.2.

- ***Long-Term Effectiveness and Permanence.*** There are no remaining risks at the completion of remedial activities.

- ***Reduction of Toxicity, Mobility or Volume with Treatment.*** Off-site thermal desorption and disposal/recycle of the excavated materials will eliminate toxicity, mobility and volume.

- ***Short-Term Effectiveness.*** The alternative will require very intensive construction activity and some potential long-term (5+ years) impacts are expected. The ability to effectively manage these extensive impacts over a sustained period is questionable.

- ***Implementability.*** The alternative is technically impracticable. The depth of excavation required and lack of a structural and hydrologic confining layer at depth prohibit the practical implementability of this alternative.

- ***Cost.*** The estimated cost is at least $195 million. A detailed estimate for this alternative has not been prepared. The listed cost was determined solely on a unit rate of $150 per cubic yard of excavated material (approximately 1.3 million CY) to provide a rough relative cost for comparison purposes. This cost, which would put an unacceptable burden on KeySpan's ratepayers in the community for a marginal reduction in risk compared to most of the other offered alternatives, coupled with the nuisance impacts on the community and the technical challenges render this alternative impractical. This alternative will not be brought forward in the evaluation process.

7.5.8 Alternative 6: No Action

- ***Overall Protection of Public Health and the Environment.*** The alternative controls the potential exposure to contaminants via institutional controls.

  The alternative achieves each RAO as described below:

  - *Prevent, to the extent practicable, contact with, or inhalation of volatiles from, contaminated groundwater*. Affected groundwater beneath the Site is not currently used for water supply and institutional controls will prevent its use in the future. Incidental contact during construction would be managed via worker health and safety plans.

  - *Prevent, to the extent practicable, the migration of NAPL beyond the boundaries of the site.* The alternative does not achieve this objective.

- *Remove, to the extent practicable, the source of groundwater contamination.* No source material is removed.

- *Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.* Direct contact is prevented solely through institutional controls.

- *Prevent, to the extent practicable, inhalation of or exposure from contaminants volatilizing from contaminants in soil.* Exposure is prevented solely through institutional controls.

▪ ***Compliance with Standards, Criteria, and Guidelines (SCGs).*** With respect to each SCG:

  - *At a minimum, to eliminate or mitigate all significant threats to public health and the environment presented by the contaminants disposed at the site through the proper application of scientific and engineering principles.* The alternative does not eliminate or mitigate all significant threats.

  - *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.* The alternative does not remove any sources of contamination.

▪ ***Long-Term Effectiveness and Permanence.*** The magnitude of the remaining risks is high in comparison to the other evaluated alternatives given the lack of source material removal.

▪ ***Reduction of Toxicity, Mobility or Volume with Treatment.*** This alternative will not address the reduction of toxicity, mobility, or volume.

▪ ***Short-Term Effectiveness.*** The alternative can be readily implemented, and little to no short-term impacts are expected.

▪ ***Implementability.*** The alternative is technically implementable.

▪ ***Cost.*** The cost to implement this task is minimal, but the alternative does not satisfy the evaluation criteria and will not be brought forward in the evaluation process.

7.6 Comparison of Alternatives

Table 7-1 summarizes estimated remedial costs for the remaining alternatives. Table 7-2 presents a comparative matrix of the remaining 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. The main evaluation categories are normalized so that each carries equal weight in the evaluation process. Each of the alternatives satisfies the criteria to some degree. The primary differences are found in long-term effectiveness, reduction of contaminant mobility, implementability, and cost.

8. Recommended Remedy

Based on the results of the comparative analysis presented in Table 7-2, Alternative 3a (Engineered soil cover system/Shallow Source Excavation (8')/Onsite NAPL Migration Barrier (50' and 120')/Offsite NAPL Migration Barrier (70')/NAPL Recovery) is the recommended remedy.

Alternative 3a received the best overall score of the evaluated alternatives. The alternative's level of overall protection of human health and the environment, reduction of contaminant mobility, and long term effectiveness offset the fact that this alternative will be more difficult and costly to implement compared to most of the other alternatives evaluated. The remedy achieves the SCG's and RAO's and is technically feasible. The combined elements of the remedy effectively prevent potential exposures to site related contaminants.

Alternatives 2, 2a, 3, 3a and 4 all satisfy the RAO's to some degree. Alternatives 2 and 2a are not sufficiently effective in preventing NAPL migration and the additional excavation considered in Alternative 2a is impracticable considering the very small amount of additional exposure prevention it provides. Alternative 3 does not address the residual contaminants north of the KeySpan parcel, nor does it prevent potential migration at depths greater than 50 feet. While there is no evidence that migration is currently occurring at greater depths, Alternative 3a provides a measure of protection against potential future migration. Alternative 4 provides little to no additional benefit above alternative 3a, while considerably increasing costs and closing down a main thoroughfare for an extended period of time for in-situ stabilization of a portion of Beach Channel Drive.

Alternative 3a effectively contains remaining contaminants on the KeySpan parcel and bulkhead area, and eliminates the need for long-term access or use restrictions to Beach Channel Drive. With proper maintenance and integration of the engineering and institutional controls into development plans, Alternative 3a can support recreational, commercial, industrial, or residential re-use of the KeySpan property and recreational use of the adjacent bulkhead parcel can resume.

References

Dvirka and Bartilucci Consulting Engineers, 1999. *Remedial Investigation/Feasibility Study Work Plan, Rockaway Park Former MGP Site.*

GEI Consultants, 2004. *Final Remedial Investigation Report Rockaway Park Former MGP Site, Rockaway Park, New York*

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, 2002. *Draft DER-10, Technical Guidance for Site Investigation and Remediation*

United States Environmental Protection Agency, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final,* October 1988.

Tables

Table 6-1
Summary of Remedial Technology Screening
Rockaway Park Former MGP Site
Rockaway Park, 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. 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. Significant earth support and dewatering systems required.	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.	NA	Not retained.
	Surfactant/Cosolvent flushing	Effective in mobilizing NAPL and when combined with other recovery technologies may achieve RAOs. Tidal action will make delivery and contact difficult.	Technology proven in controlled settings. Tidal action will be difficult to overcome.	High capital costs when compared to other alternatives.	Not retained.

Table 6-1
Summary of Remedial Technology Screening
Rockaway Park Former MGP Site
Rockaway Park, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
In Situ Treatment	In-Situ Chemical Oxidation with Persulfate, Permanganate, Ozone, or Fenton's Reagent	Effective in destroying source material and meeting the RAOs at similar sites. Tidal action and influx of extraneous oxidant scavengers make delivery and contact with target source material difficult.	Technology proven. Ability to effectively deliver oxidant under tidal conditions must be proven.	High capital and operating costs compared to other alternatives.	Not Retained.
	Six Phase Heating	Effective in low volumes. Extent of impact at Rockaway Park 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. NAPL recovery studies must be performed to predict favorable zones of capture. Tidal influence and flow direction changes may affect effectiveness.	Technology proven and readily implemented.	Low installation costs, operation and maintenance costs depend on passive versus active implementation of technology.	Retained for alternative development.
	Hydraulic Control in contained areas	Effective in maintaining hydraulic gradient into the contained area. Tidal effects at Rockaway Park may require complex modeling and pumping arrangements. Brackish nature of water may require frequent well and pump maintenance.	Technology proven and readily implemented.	Low capital cost, high long-term maintenance cost relative to other technologies.	Not retained.
	Sheet pile wall	Effective at meeting RAO for preventing migration and terminating exposure. Minimal disturbance of soils. Continuity and compatibility may are concerns. Subsurface piles present at the Rockaway may be 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.

Table 6-1
Summary of Remedial Technology Screening
Rockaway Park Former MGP Site
Rockaway Park, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
Containment	Soil/bentonite or cement/bentonite cutoff wall	Effective at meeting RAO for preventing migration and terminating exposure. However, wall construction may be difficult due to sandy soil and tidal effects. Saline condition and chemical compatibility issues must be addressed.	Technology proven and readily implemented on main site area. Depths greater than 60 to 70 feet become more difficult and time-consuming to construct.	Medium relative to other containment technologies.	Retained for alternative development.
	Jet Grouting	Effective at meeting RAO for preventing migration and terminating exposure. Saline condition and chemical compatibility issues must be addressed.	Technology proven and implementable.	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. Saline condition chemical compatibility issues must be addressed.	Technology proven and implementable.	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
Estimated Remedial Component Costs
Rockaway Park Former MGP Site and Bulkhead Areas
Rockaway, New York

Remedial Area	Remedial Action	Estimated Remedial Component Cost (millions of dollars)					
		Alternative 1 Cap, NAPL Recovery	Alternative 2 Cap, NAPL Recovery, Excavate 8’	Alternative 2a Cap, NAPL Recovery, Excavate 18’	Alternative 3 Cap, NAPL Recovery, Excavate 8’, Barrier 50’	Alternative 3a Cap, NAPL Recovery, Excavate 8’, Barriers 50’, 70’ and 120’	Alternative 4 Cap, NAPL Recovery, Excavate 8’, Barriers 50’ and 120’. In-situ Stabilization
Main Site Area and Bulkhead Area	Excavate, Treat & Dispose, Surface Cap	5.1	13.8	36.8	13.8	13.8	13.8
	NAPL Recovery / Migration Barrier	.1	.1	.1	.8	1.5	1.3
	No Action/Long-Term Monitoring	1.5	1.5	1.5	1.5	1.5	1.5
	In-situ Stabilization	NA[1]	NA	NA	NA	NA	13.9
Site Wide Costs	Design, Construction Management, and Mobilization	2.3	4.0	5.1	6.2	7.3	7.3
	Contingency	2.3	4.9	10.9	5.6	6	9.5
	TOTALS	**11.3**	**24.3**	**54.4**	**27.9**	**30.2**[2]	**47.3**

Notes:
1. NA - Not Applicable
2. Discrepancies between components and totals due to rounding.

.

Table 7-2
Remedial Action Alternatives – Comparative Analysis
Rockaway Park
Rockaway Park, New York

Criteria	Sub-Criteria	Rating[1]						Comparison Statement
		Alt. 1: Cap, NAPL Recovery	Alt. 2: Cap, NAPL Recovery, Excavate 8'	Alt. 2a: Cap, NAPL Recovery, Excavate 18'	Alt. 3: Cap, NAPL Recovery, Excavate 8', NAPL Barrier 50'	Alt 3a: Cap, NAPL Recovery, Excavate 8', NAPL Barriers 50,70, & 120'	Alt 4: Cap, NAPL Recovery, Excavate 8', NAPL Barriers 50'& 120', In-situ Stabilization	
Overall Protection of Human Health and the Environment		6	5	4	3	1	1	All of the alternatives with shallow source excavations and migration barriers are protective of human health and the environment, but 3a and 4 have deeper barriers and offsite (bulkhead) remedial measures providing potentially additional protection.
	Score[2]	**6**	**5**	**4**	**3**	**1**	**1**	
New York State or Site-Specific SCGs	Soil	6	3	2	3	3	1	Alternatives were ranked based on the volume of source material removed, treated, and/or stabilized.
	Groundwater	6	5	4	3	1	1	Alternatives were ranked based on whether they included NAPL recovery or NAPL migration barriers, depth of barriers, NAPL recovery, and quantity of source removal/ treatment/stabilization.
	Score	**6**	**4**	**3**	**3**	**2**	**1**	
Long-Term Effectiveness and Permanence	Permanence of Remedial Alternative	4	4	4	1	1	1	All of the alternatives are expected to be a permanent remedy for the Site; however the alternatives that include a barrier along with NAPL collection help prevent migration of remaining contaminants.
	Magnitude of Remaining Risk	6	4	4	3	1	1	Alternatives 3 and 4 pose the least risk that additional remediation work will be required in the future.
	Adequacy of Controls	1	1	1	1	1	1	All alternatives will provide equal controls.
	Reliability of Controls	1	1	1	1	1	1	All alternatives will provide equal controls.
	Score	**3**	**2.5**	**2.5**	**1.25**	**1**	**1**	

Table 7-2
Remedial Action Alternatives – Comparative Analysis
Rockaway Park
Rockaway Park, New York

Criteria	Sub-Criteria	Rating[1]						Comparison Statement
		Alt. 1: Cap, NAPL Recovery	Alt. 2: Cap, NAPL Recovery, Excavate 8'	Alt. 2a: Cap, NAPL Recovery, Excavate 18'	Alt. 3: Cap, NAPL Recovery, Excavate 8', NAPL Barrier 50'	Alt 3a: Cap, NAPL Recovery, Excavate 8', NAPL Barriers 50,70, & 120'	Alt 4: Cap, NAPL Recovery, Excavate 8', NAPL Barriers 50'& 120', In-situ Stabilization	
Reduction of Toxicity, Mobility, and Volume	Amount of material destroyed or treated	6	3	2	3	3	1	All alternatives are relatively equal in volume of material treated or destroyed, but Alternative 4 will treat more contaminants due to the use of in-situ stabilization on Beach Channel Drive and the bulkhead area.
	Degree of Toxicity, Mobility, or Volume reduced	6	5	4	3	2	1	Alternative 4 reduces migration more than 3 and 3a, and provides a greater reduction in mobility than 2a does in regards to toxicity and volume.
	Irreversibility	1	1	1	1	1	1	All alternatives are permanent.
	Residuals Remaining	6	2	1	2	2	2	Alternative 2a would remove the largest volume of impacted materials from the Site.
	Score	**4.75**	**2.75**	**2**	**2.25**	**2**	**1.25**	
Short-Term Impacts and Effectiveness	Protection of Community during Remedial Action	1	2	5	2	4	5	All alternatives require some degree of excavation and off-site transport of impacted soils that will potentially impact the community and will require the implementation of appropriate controls during construction (air monitoring, dust suppression, etc.) and times when portions of local roads will be closed. But Alternative 1 is the least intrusive.
	Environmental Impacts	1	1	1	1	1	1	There are no foreseeable adverse environmental impacts for any alternative.
	Time Required to Meet Remedial Objectives	1	2	3	4	5	5	Alternative one could be completed in 6 months, and all of the alternatives could be completed in 2.5 years or less.
	Protection of Workers	1	2	6	2	2	2	Alternative 1 has the least amount of construction activity, and Alternative 2a is the only alternative that includes deeper excavation into the saturated zone.
	Score	**1**	**1.75**	**3.75**	**2.25**	**3**	**3.25**	

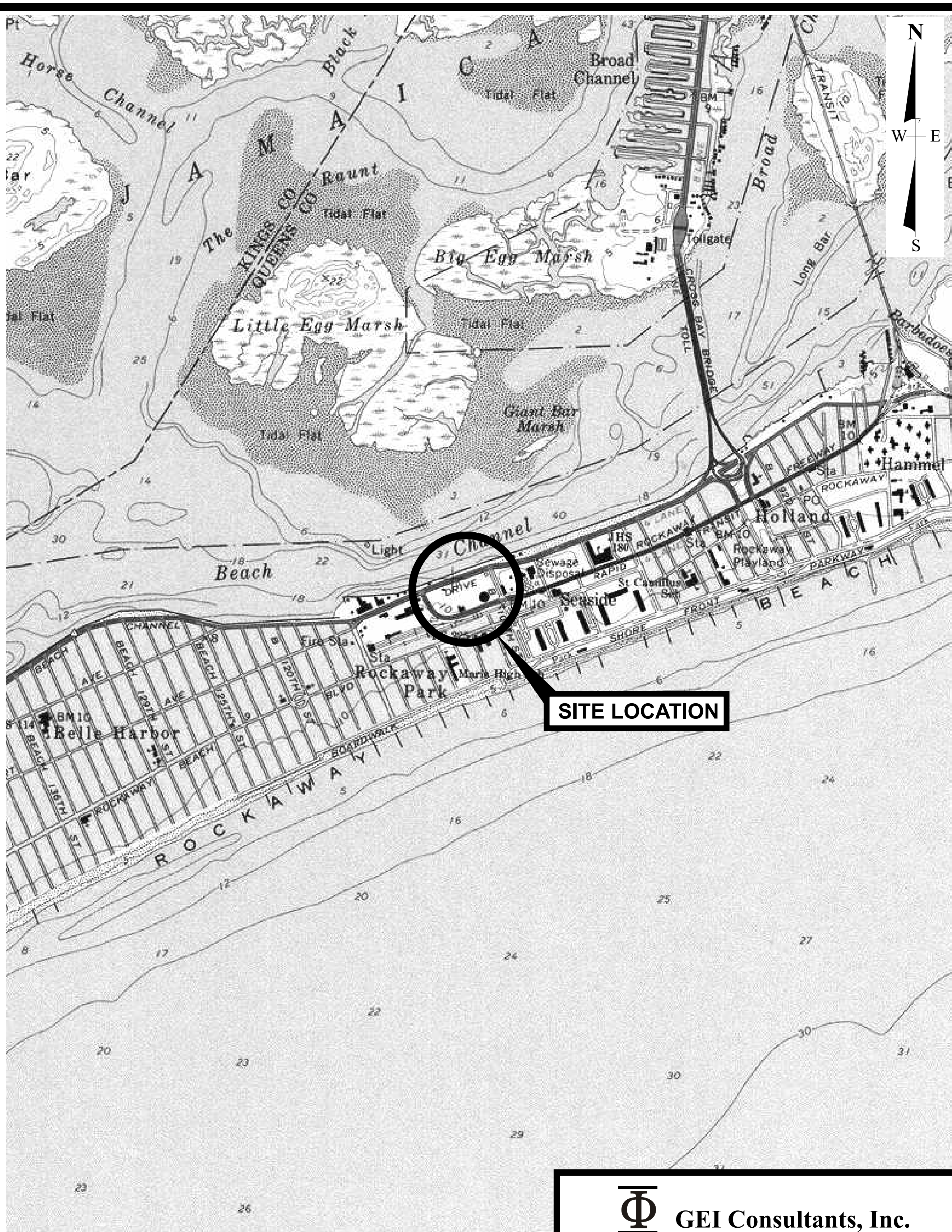
Table 7-2
Remedial Action Alternatives – Comparative Analysis
Rockaway Park
Rockaway Park, New York

Criteria	Sub-Criteria	Rating[1]						Comparison Statement
		Alt. 1: Cap, NAPL Recovery	Alt. 2: Cap, NAPL Recovery, Excavate 8'	Alt. 2a: Cap, NAPL Recovery, Excavate 18'	Alt. 3: Cap, NAPL Recovery, Excavate 8', NAPL Barrier 50'	Alt 3a: Cap, NAPL Recovery, Excavate 8', NAPL Barriers 50,70, & 120'	Alt 4: Cap, NAPL Recovery, Excavate 8', NAPL Barriers 50'& 120', In-situ Stabilization	
Implementability	Technical Feasibility	1	2	6	3	4	5	Alternative 1 is the least construction intensive alternative with the highest technical feasibility.
	Administrative Feasibility	1	2	6	3	3	5	Alternative 1 is the least intrusive alternative.
	Availability of Services	1	1	1	4	5	6	The majority of site work will be completed with conventional construction equipment, those alternatives requiring the use of specialized equipment for work at depth may have slightly less available.
	Score	**1**	**1.67**	**4.33**	**3.33**	**4**	**5.33**	
Cost	Capital Costs	1	2	6	3	4	5	Capital costs for construction dewatering and treatment of impacted soils drive the costs of the remedies. Those alternatives with larger excavation volumes, disposal volumes, and/or dewatering costs have increased associated capital costs.
	O&M costs	1	1	1	1	1	1	All alternatives will require similar post remedy monitoring programs.
	Score	**1**	**1.5**	**3.5**	**2**	**2.5**	**3**	
Total Score		**22.75**	**19.17**	**23.08**	**17.08**	**15.50**	**15.83**	

Note:

1. Sub-criteria score are based on a qualitative forced ranking scale. The alternative with the best rating receives a score of 1, the 2nd best – a score of 2, and so on. If alternatives are equal in rating, ties are included (i.e., if Alternative 1 is the best, it receives a score of 1, but if Alternatives 3 and 4 are the next equal in scale, then they both will receive a score of 2, the next rated Alternative will receive a 4 since it is the fourth rated Alternative). The tie scoring system is used to prevent the last place rated alternative from receiving a score of 2, if all of the other alternatives are justifiably scored with the highest rating.
2. Sub-criteria scores for each major criteria are summed, and then divided by the number of sub-criteria so that the main criteria receive the same overall weighting, regardless of the number of sub-criteria.

Figures



2000 1000 0 2000 4000

GRAPHIC SCALE IN FEET

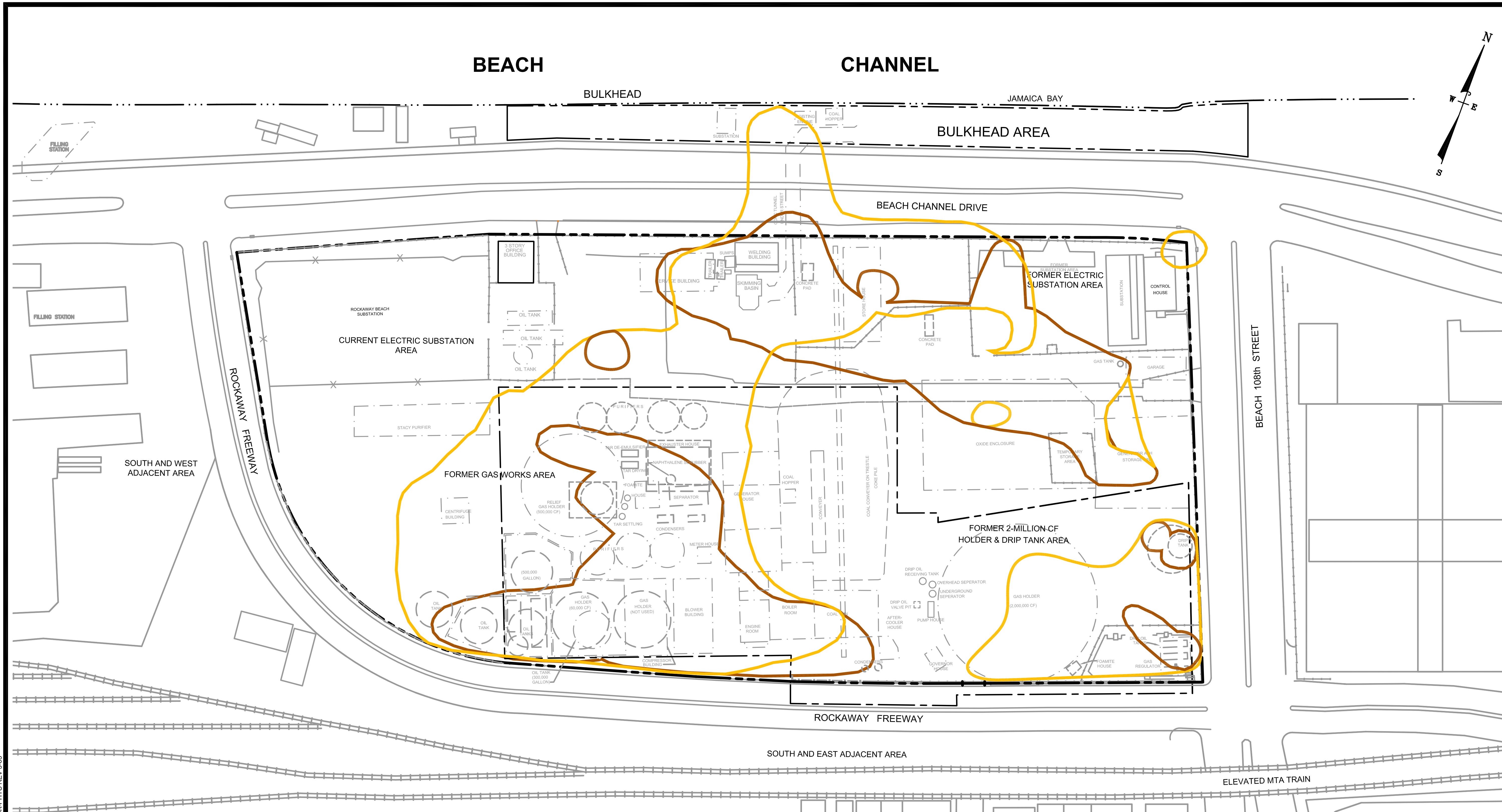
SOURCE:
MAP CREATED WITH TOPO!™ ©2000 WILDFIRE PRODUCTIONS (www.topo.com)

KEYSPAN\ROCKAWAY\FS\ROCK-FS-LOC.CDR

GEI Consultants, Inc.

FIGURE 1-1
SITE LOCATION MAP

KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK



LEGEND

(yellow outline)	BLEBS, GLOBS, LENSES, GRAIN COATING, SHEENS
(brown outline)	TAR SATURATED

100 50 0 100 200

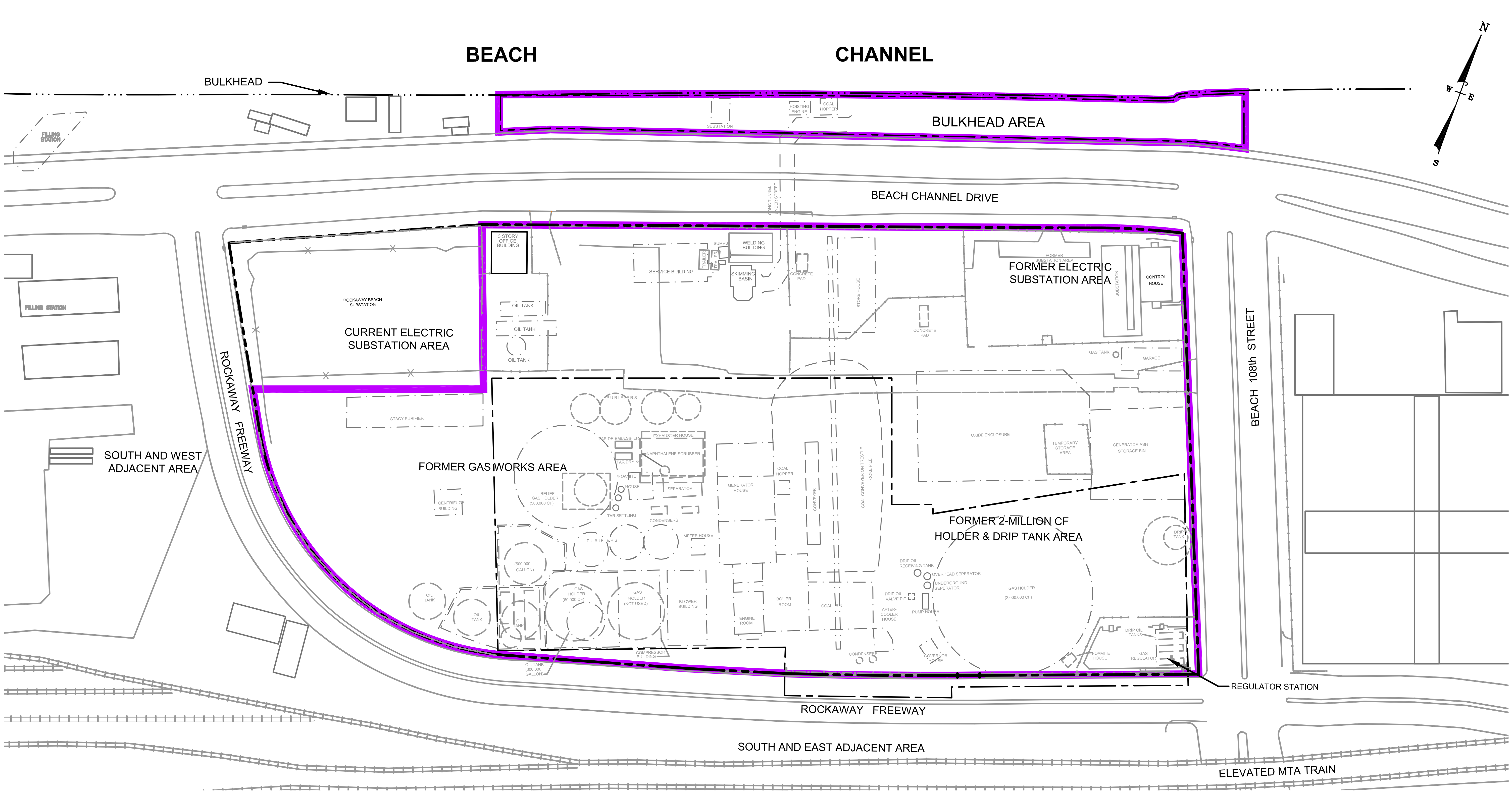
GRAPHIC SCALE IN FEET

GEI Consultants, Inc.

FIGURE 3-1
LATERAL EXTENT OF PHYSICAL OBSERVATIONS IN SOIL

KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK

KEYSPAN\ROCKAWAY PARK\FS RPT1-2004\ROCK-PHYS REV 3-03



LEGEND

SITE WIDE CAP AREA

100 50 0 100 200

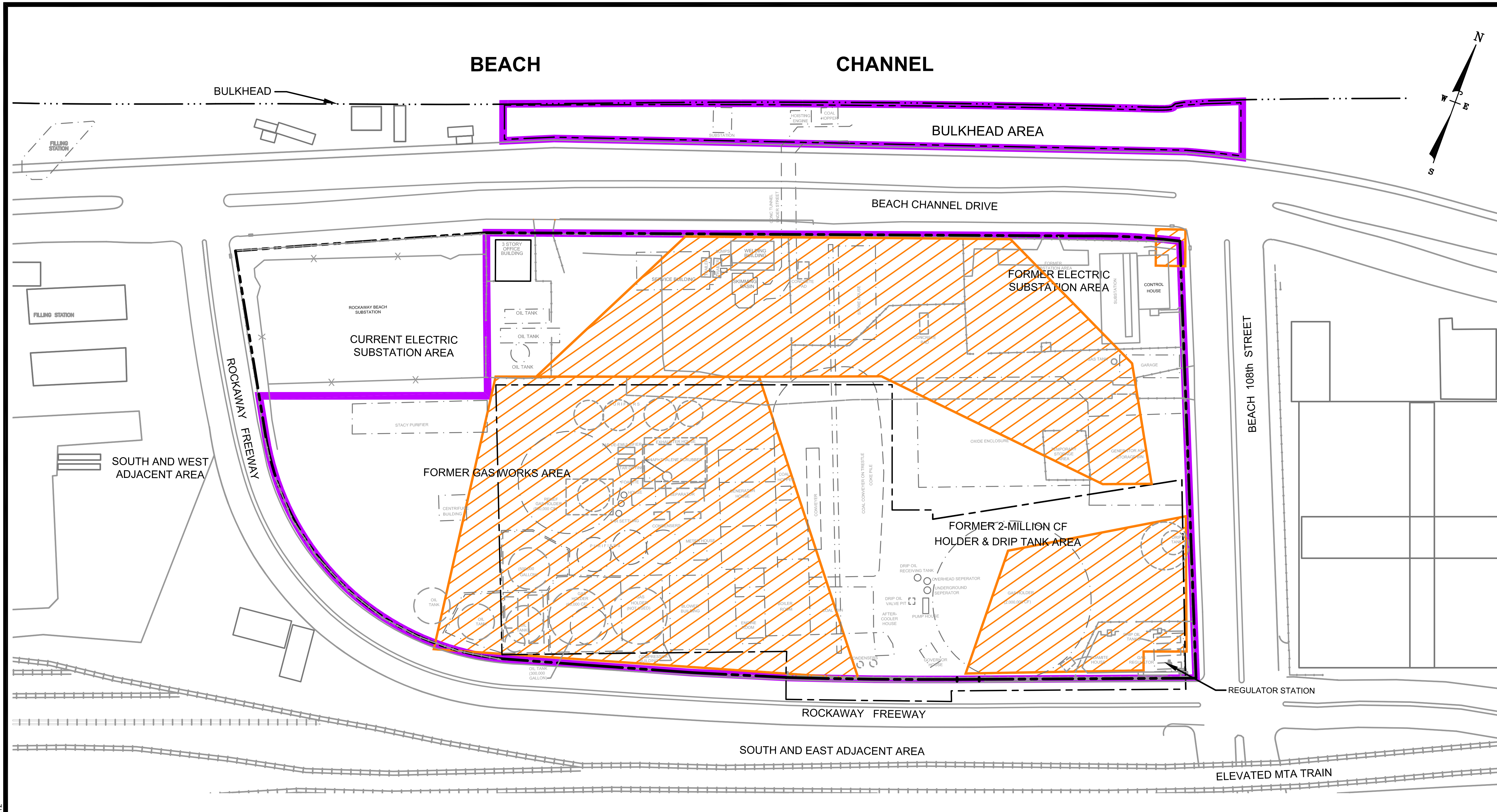
GRAPHIC SCALE IN FEET

GEI Consultants, Inc.

FIGURE 7-1
REMEDIAL ACTION ALTERNATIVE 1

KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK

KEYSPAN\ROCKAWAY\FS RPT\1-2004\ROCK-ALT1



LEGEND

SITE WIDE CAP AREA

SHALLOW EXCAVATION AREA (APPROXIMATELY 8 FEET)

100 50 0 100 200

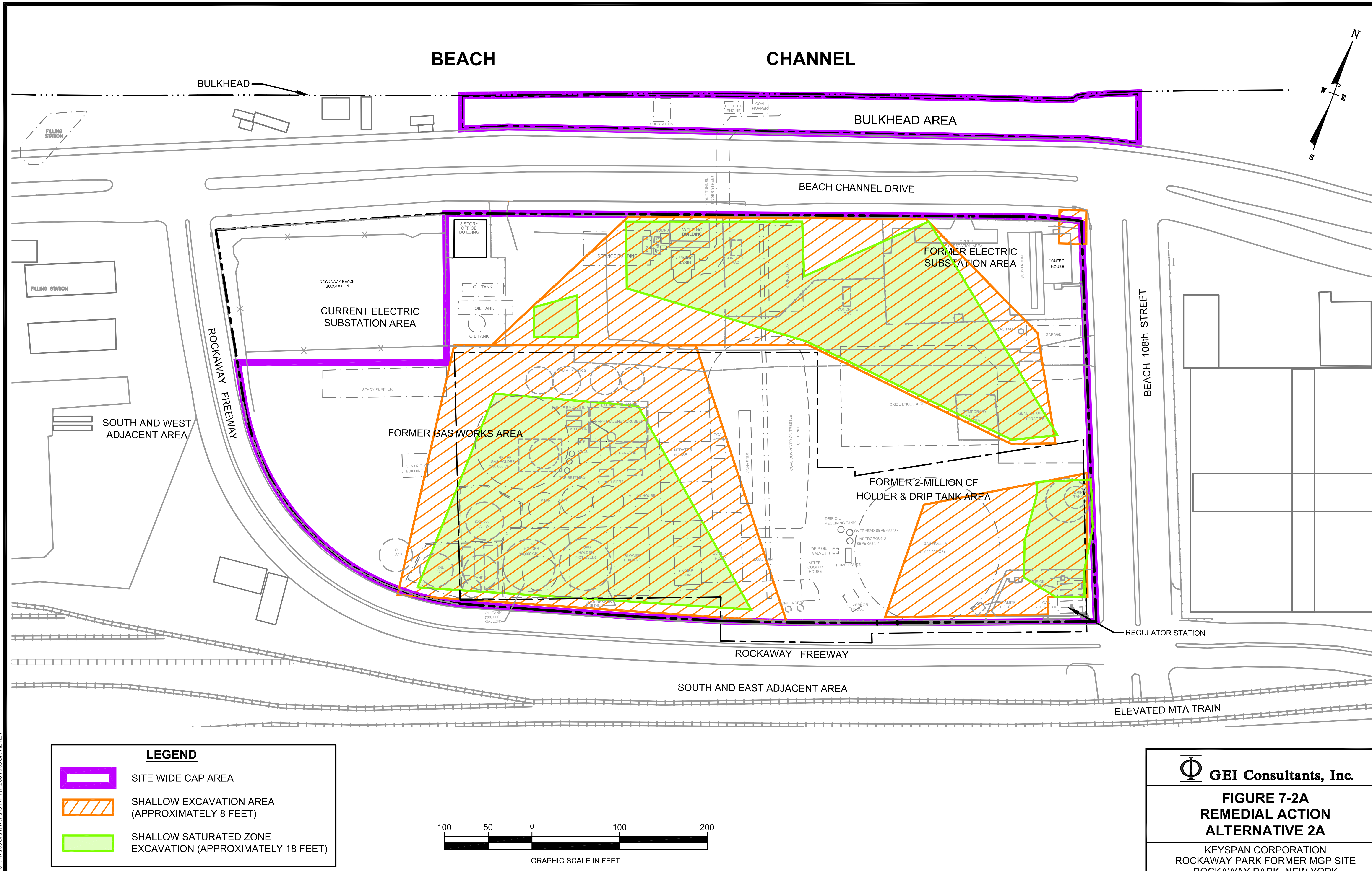
GRAPHIC SCALE IN FEET

GEI Consultants, Inc.

FIGURE 7-2
REMEDIAL ACTION
ALTERNATIVE 2

KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK

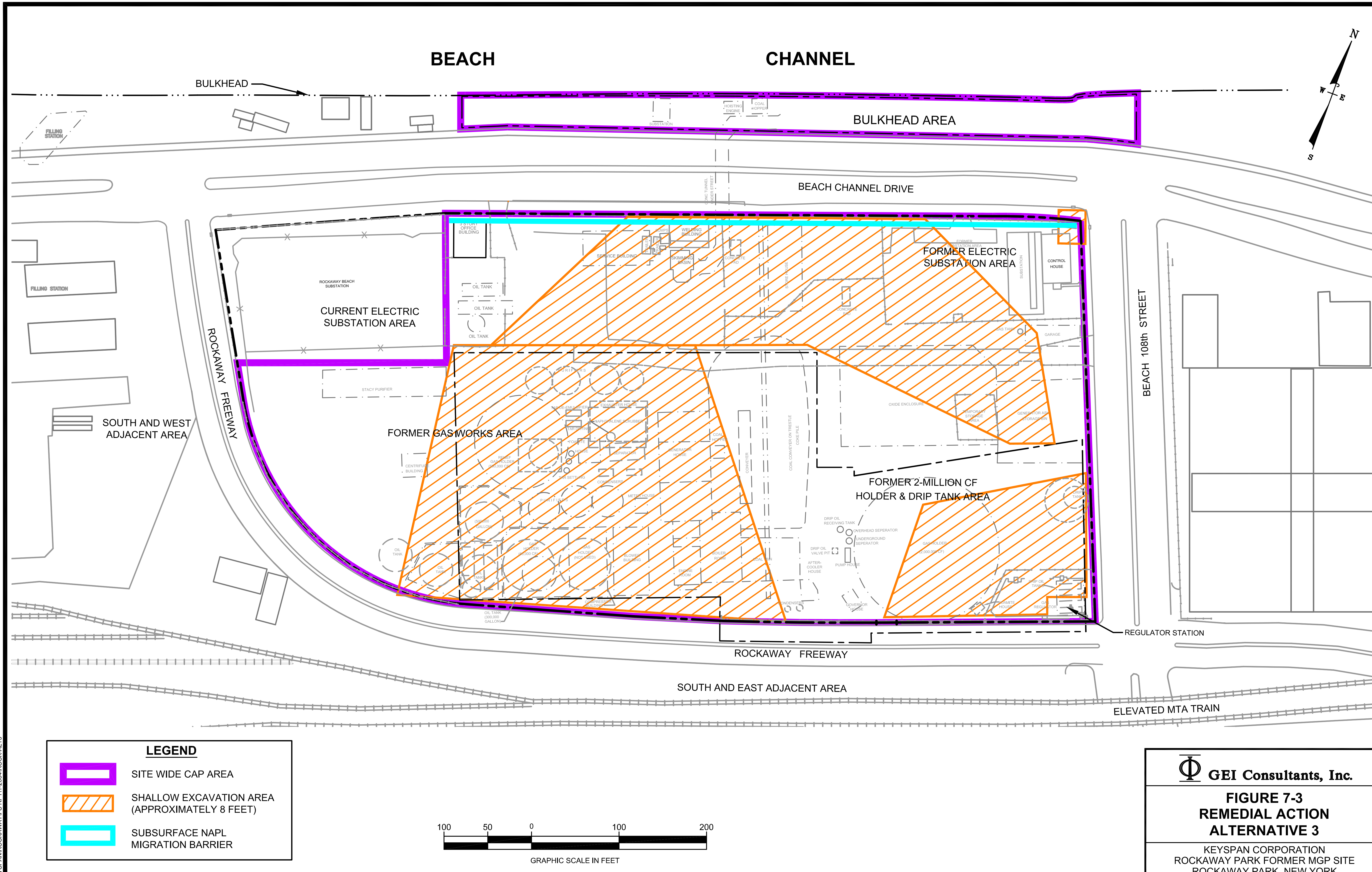
KEYSPAN\ROCKAWAY\FS RPT\1-2004\ROCK-ALT2



GEI Consultants, Inc.

FIGURE 7-2A
REMEDIAL ACTION
ALTERNATIVE 2A

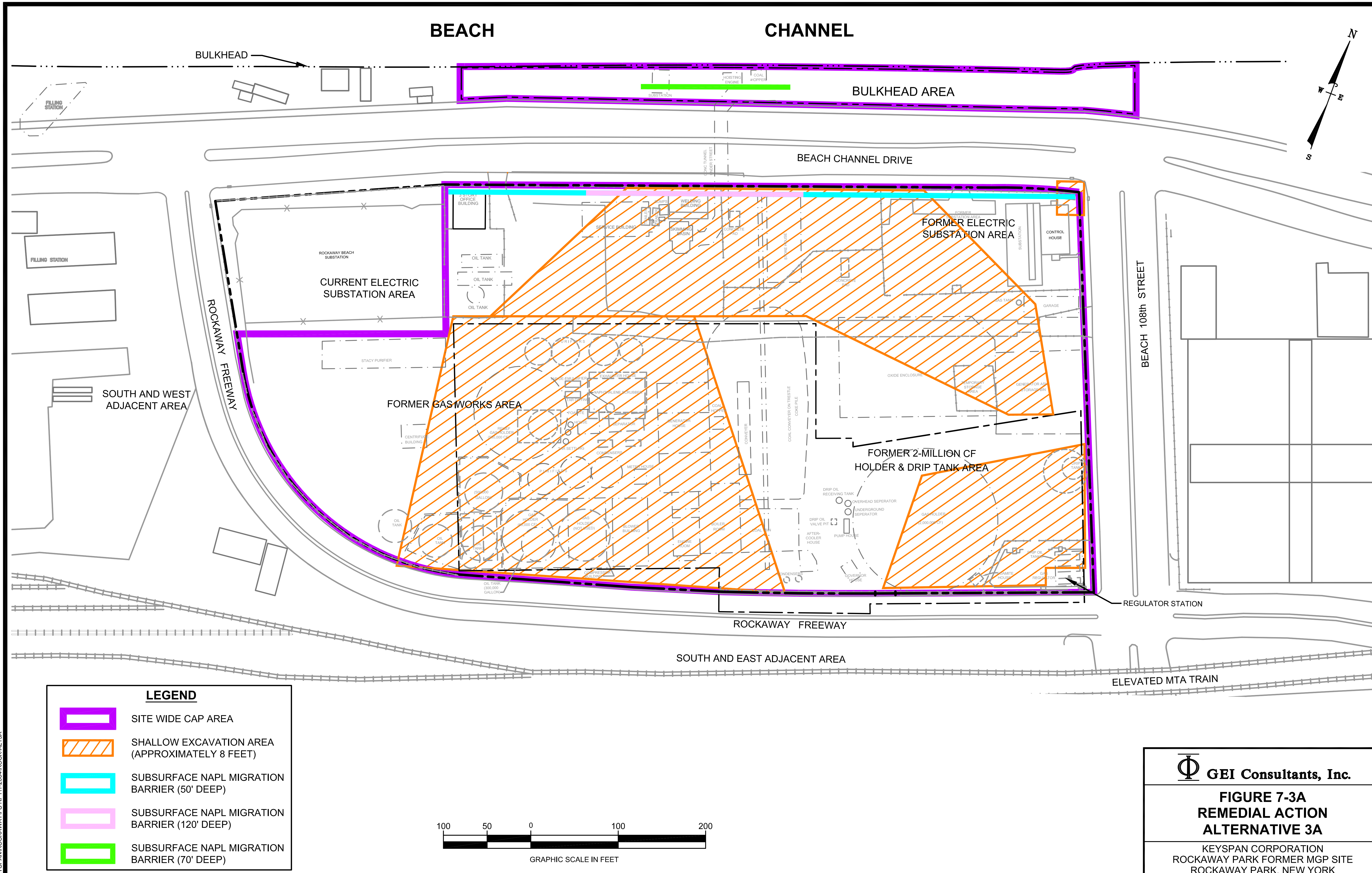
KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK



GEI Consultants, Inc.

FIGURE 7-3
REMEDIAL ACTION
ALTERNATIVE 3

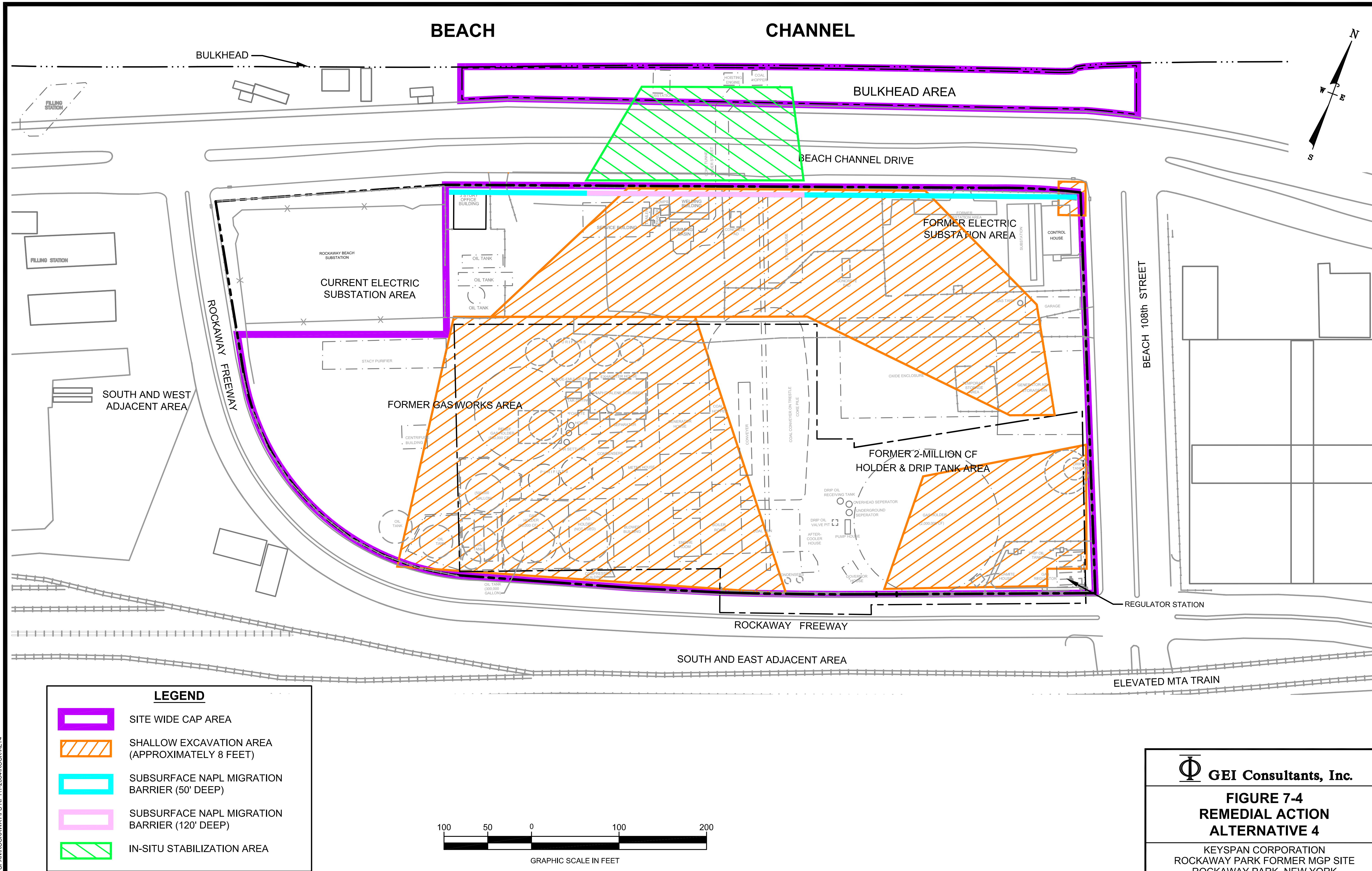
KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK



GEI Consultants, Inc.

FIGURE 7-3A
REMEDIAL ACTION ALTERNATIVE 3A

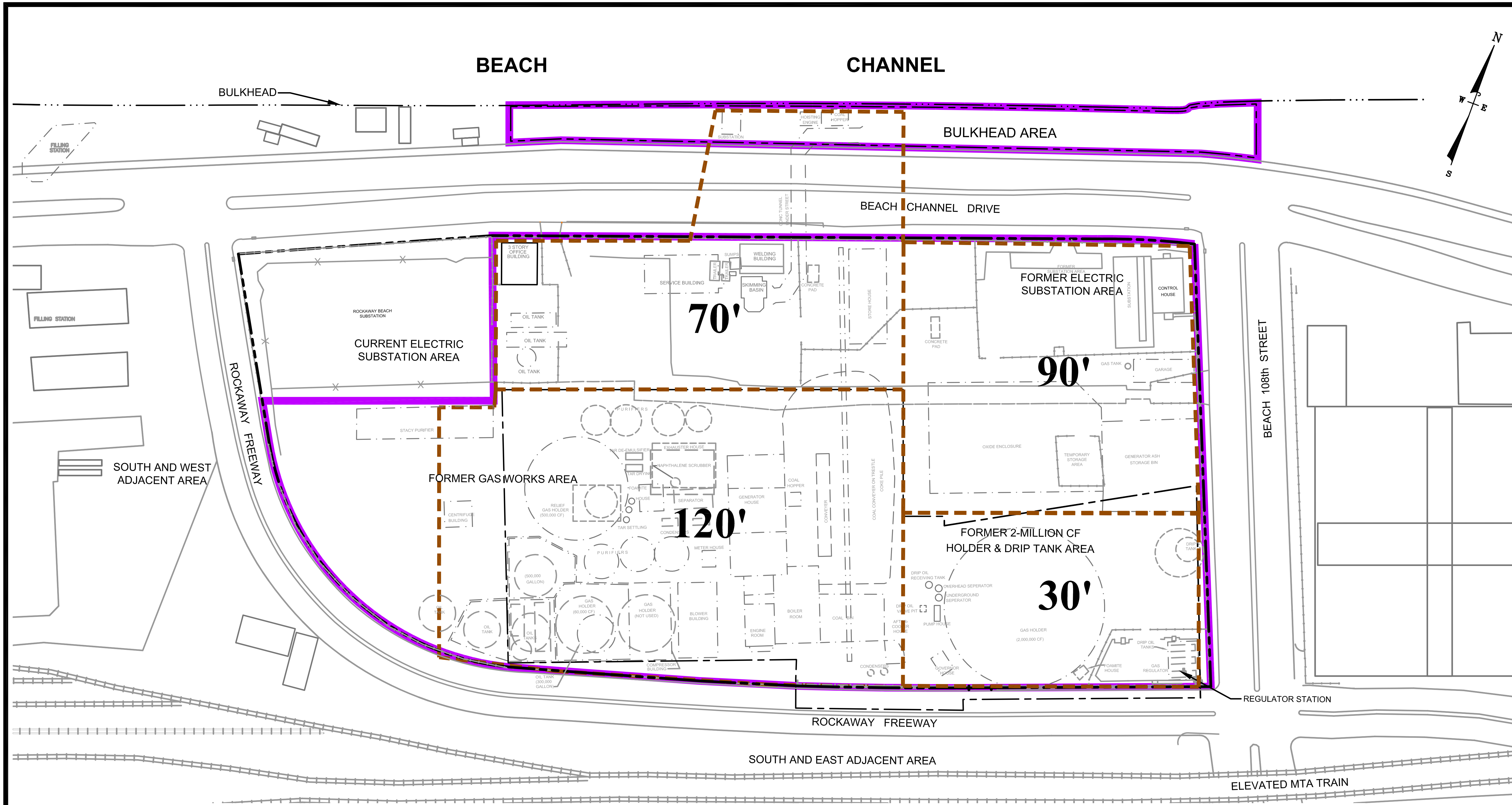
KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK



GEI Consultants, Inc.

FIGURE 7-4
REMEDIAL ACTION ALTERNATIVE 4

KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK



LEGEND

SITE WIDE CAP AREA

30' EXCAVATION ZONE AND DEPTH IN FEET

100 50 0 100 200

GRAPHIC SCALE IN FEET

GEI Consultants, Inc.

FIGURE 7-5
REMEDIAL ACTION ALTERNATIVE 5

KEYSPAN CORPORATION
ROCKAWAY PARK FORMER MGP SITE
ROCKAWAY PARK, NEW YORK

KEYSPAN\ROCKAWAY\FS RPT\1-2004\ROCK-ALT5

Appendix A

Remedial Alternative Cost Estimates

Table A-1
Detailed Cost Estimate for Remedial Alternative 1
Rockaway Park
Rockaway Park, New York

Remedial Component	Unit	Unit Price		Remedial Alternative 1 Cap, NAPL Recovery Quantity	Total Cost	
COMMON COST COMPONENTS						
Pre-construction						
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$	300,000	1	$	300,000
2 Permitting and Regulatory submittals	Lump Sum	$	75,000	1	$	75,000
3 Pre-construction Analytical Sampling	Lump Sum	$	50,000	1	$	50,000
				Subtotal	$	425,000
				% Total Cost		4%
Construction Management						
1 Construction Oversight	Day	$	1,920	155	$	297,600
2 Air Monitoring during excavations	Day	$	960	125	$	120,000
3 Air Logics Air System	Month	$	120,000	6	$	720,000
3 Site Survey (Pre-construction and Post-Remediation)	Acre	$	10,000	10	$	100,000
				Subtotal	$	1,237,600
				% Total Cost		11%
General Conditions						
1 Mobilization/Demobilization	Lump Sum	$	250,000	1	$	450,000
2 Site Preparation (debris and shrub removal)	Lump Sum	$	50,000	1	$	50,000
3 Demolition (concrete structures as encountered)	Lump Sum	$	100,000	1	$	100,000
4 Temporary Offices	Month	$	3,000	7	$	21,000
5 Temporary Utilities	Lump Sum	$	25,000	1	$	25,000
				Subtotal	$	646,000
				% Total Cost		6%
REMEDIAL COMPONENTS						
Engineered Cap						
1 Excavation of impacted soil from 0-2 feet	Cubic Yard	$	25	28,244	$	706,111
2 Construction of Surface Cap, Geotextile, Base, Binder, and Wearing Course	Square Foot	$	2	381,300	$	743,535
3 Backfill	Cubic Yard	$	30	25,420	$	762,600
				Subtotal	$	2,212,246
				% Total Cost		20%
Shallow Source Unsaturated Zone Excavation (2-8')						
1 Clear Excavation Area (Sewerline support/relocation)	Acre	$	7,500	0	$	-
2 Relocation of Power Lines other utilities in the remediation area	Lump Sum	$	400,000	0	$	-
3 Excavation of impacted soils from 2-8 feet	Cubic Yard	$	25	-	$	-
4 Backfill	Cubic Yard	$	30	-	$	-
				Subtotal	$	-
				% Total Cost		0%
Solid Waste Disposal						
1 Disposal Costs and Hauling of Bulky Waste	Ton	$	149	1,000	$	149,000
2 Disposal Costs Hauling and Thermal Treatment	Ton	$	65	42,367	$	2,753,833
				Subtotal	$	2,902,833
				% Total Cost		26%
NAPL Recovery System						
1 NAPL Recovery and Treatment System - 3 wells	Lump Sum	$	100,000	1	$	100,000
				Subtotal	$	100,000
				% Total Cost		1%
Subsurface NAPL Migration Barrier						
1 Soil Bentonite Wall	Cubic Yard	$	150	-	$	-
2 Wastage Handling and Disposal (25% of wall)	Cubic Yard	$	80	-	$	-
				Subtotal	$	-
				% Total Cost		0%
In-situ Stabilization						
1 In-situ Stabilization of Beach Channel Dr & Bulkhead (70' deep)	Cubic Yard	$	200	-	$	-
2 Wastage Handling and Disposal (25% of volume)	Cubic Yard	$	80		$	-
				Subtotal	$	-
				% Total Cost		0%
Long-term Monitoring and Reporting Costs						
1 Periodic Monitoring, Reporting, and Maintenance (I=5%)	Year	$	100,000	30	$	1,537,245
				Subtotal	$	1,537,245
				% Total Cost		14%
REMEDIAL COST SUMMARY						
Total Capital costs without contingency					$	7,523,679
Total O & M costs					$	1,537,245
Total No Contingency Costs					$	9,060,925
Contingency (25%)					$	2,265,231
				% TOTAL COSTS		**20%**
				TOTAL COST	**$**	**11,326,156**

Table A-2
Detailed Cost Estimate for Remedial Alternative 2
Rockaway Park
Rockaway Park, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 2 Cap, Shallow Source Removal (8'), NAPL Recovery Quantity	Total Cost
COMMON COST COMPONENTS				
Pre-construction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 600,000	1	$ 600,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 Pre-construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 800,000
			% Total Cost	3%
Construction Management				
1 Construction Oversight	Day	$ 1,920	280	$ 537,600
2 Air Monitoring during excavations	Day	$ 960	250	$ 240,000
3 Air Logics Air System	Month	$ 120,000	12	$ 1,440,000
3 Site Survey (Pre-construction and Post-Remediation)	Acre	$ 10,000	10	$ 100,000
			Subtotal	$ 2,317,600
			% Total Cost	10%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 700,000
2 Site Preparation (debris and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Demolition (concrete structures as encountered)	Lump Sum	$ 100,000	1	$ 100,000
4 Temporary Offices	Month	$ 3,000	13	$ 39,000
5 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
			Subtotal	$ 914,000
			% Total Cost	4%
REMEDIAL COMPONENTS				
Engineered Cap				
1 Excavation of impacted soil from 0-2 feet	Cubic Yard	$ 25	28,244	$ 706,111
2 Construction of Surface Cap, Geotextile, Base, Binder, and Wearing Course	Square Foot	$ 2	381,300	$ 743,535
3 Backfill	Cubic Yard	$ 30	25,420	$ 762,600
			Subtotal	$ 2,212,246
			% Total Cost	9%
Shallow Source Unsaturated Zone Excavation (2-8')				
1 Clear Excavation Area (Sewer line support/relocation)	Acre	$ 7,500	5.23	$ 39,239
2 Relocation of Power Lines other utilities in the remediation area	Lump Sum	$ 400,000	1	$ 400,000
3 Excavation of impacted soils from 2-8 feet	Cubic Yard	$ 25	51,741	$ 1,293,533
4 Backfill	Cubic Yard	$ 30	62,090	$ 1,862,688
			Subtotal	$ 3,595,460
			% Total Cost	15%
Solid Waste Disposal				
1 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
2 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	119,979	$ 7,798,613
			Subtotal	$ 7,947,613
			% Total Cost	33%
NAPL Recovery System				
1 NAPL Recovery and Treatment System - 3 wells	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 100,000
			% Total Cost	0%
Subsurface NAPL Migration Barrier				
1 Soil Bentonite Wall	Cubic Yard	$ 150	-	$ -
2 Wastage Handling and Disposal (25% of wall)	Cubic Yard	$ 80	-	$ -
			Subtotal	$ -
			% Total Cost	0%
In-situ Stabilization				
1 In-situ Stabilization of Beach Channel Dr & Bulkhead (70' deep)	Cubic Yard	$ 200	-	$ -
2 Wastage Handling and Disposal (25% of volume)	Cubic Yard	$ 80		$ -
			Subtotal	$ -
			% Total Cost	0%
Long-term Monitoring and Reporting Costs				
1 Periodic Monitoring, Reporting, and Maintenance (I=5%)	Year	$ 100,000	30	$ 1,537,245
			Subtotal	$ 1,537,245
			% Total Cost	6%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 17,886,920
Total O & M costs				$ 1,537,245
Total No Contingency Costs				$ 19,424,165
Contingency (25%)				$ 4,856,041
			% TOTAL COSTS	**20%**
			TOTAL COST	**$ 24,280,206**

Table A-2a
Detailed Cost Estimate for Remedial Alternative 2a
Rockaway Park
Rockaway Park, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 2a Cap, Shallow Source Removal (18'), NAPL Recovery Quantity	Total Cost
COMMON COST COMPONENTS				
Pre-construction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 600,000	1	$ 600,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 Pre-construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 800,000
			% Total Cost	1%
Construction Management				
1 Construction Oversight	Day	$ 1,920	405	$ 777,600
2 Air Monitoring during excavations	Day	$ 960	375	$ 360,000
3 Air Logics Air System	Month	$ 120,000	18	$ 2,160,000
3 Site Survey (Pre-construction and Post-Remediation)	Acre	$ 10,000	10	$ 100,000
			Subtotal	$ 3,397,600
			% Total Cost	6%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 700,000
2 Site Preparation (debris and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Demolition (concrete structures as encountered)	Lump Sum	$ 100,000	1	$ 100,000
4 Temporary Offices	Month	$ 3,000	19	$ 57,000
5 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
			Subtotal	$ 932,000
			% Total Cost	2%
REMEDIAL COMPONENTS				
Engineered Cap				
1 Excavation of impacted soil from 0-2 feet	Cubic Yard	$ 25	28,244	$ 706,111
2 Construction of Surface Cap, Geotextile, Base, Binder, and Wearing Course	Square Foot	$ 2	381,300	$ 743,535
3 Backfill	Cubic Yard	$ 30	25,420	$ 762,600
			Subtotal	$ 2,212,246
			% Total Cost	4%
Shallow Source Unsaturated Zone Excavation (2-8')				
1 Clear Excavation Area (Sewer line support/relocation)	Acre	$ 7,500	5.23	$ 39,239
2 Relocation of Power Lines other utilities in the remediation area	Lump Sum	$ 400,000	1	$ 400,000
3 Excavation of impacted soils from 2-8 feet	Cubic Yard	$ 25	51,741	$ 1,293,533
4 Backfill	Cubic Yard	$ 30	62,090	$ 1,862,688
			Subtotal	$ 3,595,460
			% Total Cost	7%
Shallow Source Saturated Excavation (8-18')				
1 Excavation of source material soil from 8-18'	Cubic Yard	25	46,296	$ 1,157,407
2 On-site Treatment system for water from dewatering operations (400gpm)	Lump Sum	$ 1,000,000	1	$ 1,000,000
3 Dewatering Sat. zone from 8-18 (Treatment system O&M and Discharge Costs)	Gallons	$ 0.06	105,120,000	$ 6,307,200
4 Excavation Sheeting & Support (Braced Sheeting, 40 foot depth)	Square Feet	$ 25	152,000	$ 3,800,000
5 Bracing cost for sheeting	Exposed SF	$ 15	304,000	$ 4,560,000
6 Backfill	Cubic Yard	30	55,556	$ 1,666,667
			Subtotal	$ 18,491,274
			% Total Cost	34%
Solid Waste Disposal				
1 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
2 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	189,423	$ 12,312,502
			Subtotal	$ 12,461,502
			% Total Cost	23%
NAPL Recovery System				
1 NAPL Recovery and Treatment System - 3 wells	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 100,000
			% Total Cost	0%
Subsurface NAPL Migration Barrier				
1 Soil Bentonite Wall	Cubic Yard	$ 150	-	$ -
2 Wastage Handling and Disposal (25% of wall)	Cubic Yard	$ 80	-	$ -
			Subtotal	$ -
In-situ Stabilization				
1 In-situ Stabilization of Beach Channel Dr & Bulkhead 70' deep)	Cubic Yard	$ 200	-	$ -
2 Wastage Handling and Disposal (25% of volume)	Cubic Yard	$ 80		$ -
			Subtotal	$ -
			% Total Cost	0%
Long-term Monitoring and Reporting Costs				
1 Periodic Monitoring, Reporting, and Maintenance (I=5%)	Year	$ 100,000	30	$ 1,537,245
			Subtotal	$ 1,537,245
			% Total Cost	3%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 41,990,083
Total O & M costs				$ 1,537,245
Total No Contingency Costs				$ 43,527,328
Contingency (25%)				$ 10,881,832
			% TOTAL COSTS	**20%**
			TOTAL COST	**$ 54,409,160**

Table A-3
Detailed Cost Estimate for Remedial Alternative 3
Rockaway Park
Rockaway Park, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 3 Cap, Shallow Source Removal (8'), NAPL Recovery, Barrier (50') Quantity	Total Cost
COMMON COST COMPONENTS				
Pre-construction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 600,000	1	$ 600,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 Pre-construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 800,000
			% Total Cost	3%
Construction Management				
1 Construction Oversight	Day	$ 1,920	530	$ 1,017,600
2 Air Monitoring during excavations	Day	$ 960	500	$ 480,000
3 Air Logics Air System	Month	$ 120,000	24	$ 2,880,000
3 Site Survey (Pre-construction and Post-Remediation)	Acre	$ 10,000	10	$ 100,000
			Subtotal	$ 4,477,600
			% Total Cost	16%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 700,000
2 Site Preparation (debris and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Demolition (concrete structures as encountered)	Lump Sum	$ 100,000	1	$ 100,000
4 Temporary Offices	Month	$ 3,000	25	$ 75,000
5 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
			Subtotal	$ 950,000
			% Total Cost	3%
REMEDIAL COMPONENTS				
Engineered Cap				
1 Excavation of impacted soil from 0-2 feet	Cubic Yard	$ 25	28,244	$ 706,111
2 Construction of Surface Cap, Geotextile, Base, Binder, and Wearing Course	Square Foot	$ 2	381,300	$ 743,535
3 Backfill	Cubic Yard	$ 30	25,420	$ 762,600
			Subtotal	$ 2,212,246
			% Total Cost	8%
Shallow Source Unsaturated Zone Excavation (2-8')				
1 Clear Excavation Area (Sewer line support/relocation)	Acre	$ 7,500	5.23	$ 39,239
2 Relocation of Power Lines other utilities in the remediation area	Lump Sum	$ 400,000	1	$ 400,000
3 Excavation of impacted soils from 2-8 feet	Cubic Yard	$ 25	51,741	$ 1,293,533
4 Backfill	Cubic Yard	$ 30	62,090	$ 1,862,688
			Subtotal	$ 3,595,460
			% Total Cost	13%
Solid Waste Disposal				
1 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
2 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	119,979	$ 7,798,613
			Subtotal	$ 7,947,613
			% Total Cost	29%
NAPL Recovery System				
1 NAPL Recovery and Treatment System - 3 wells	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 100,000
			% Total Cost	0%
Subsurface NAPL Migration Barrier				
1 Soil Bentonite Wall	Cubic Yard	$ 150	3,944	$ 591,667
2 Wastage Handling and Disposal (25% of wall)	Cubic Yard	$ 80	986	$ 78,889
			Subtotal	$ 670,556
			% Total Cost	2%
In-situ Stabilization				
1 In-situ Stabilization of Beach Channel Dr & Bulkhead (70' deep)	Cubic Yard	$ 200	-	$ -
2 Wastage Handling and Disposal (25% of volume)	Cubic Yard	$ 80		$ -
			Subtotal	$ -
			% Total Cost	0%
Long-term Monitoring and Reporting Costs				
1 Periodic Monitoring, Reporting, and Maintenance (I=5%)	Year	$ 100,000	30	$ 1,537,245
			Subtotal	$ 1,537,245
			% Total Cost	6%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 20,753,475
Total O & M costs				$ 1,537,245
Total No Contingency Costs				$ 22,290,720
Contingency (25%)				$ 5,572,680
			% TOTAL COSTS	**20%**
			TOTAL COST	**$ 27,863,401**

Table A-3a
Detailed Cost Estimate for Remedial Alternative 3a
Rockaway Park
Rockaway Park, New York

			Remedial Alternative 3a Cap, Shallow Source Removal (8'), NAPL Recovery, Barriers (50', 70', and 120')	
Remedial Component	**Unit**	**Unit Price**	**Quantity**	**Total Cost**
COMMON COST COMPONENTS				
Pre-construction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 600,000	1	$ 600,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 Pre-construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 800,000
			% Total Cost	3%
Construction Management				
1 Construction Oversight	Day	$ 1,920	655	$ 1,257,600
2 Air Monitoring during excavations	Day	$ 960	625	$ 600,000
3 Air Logics Air System	Month	$ 120,000	30	$ 3,600,000
3 Site Survey (Pre-construction and Post-Remediation)	Acre	$ 10,000	10	$ 100,000
			Subtotal	$ 5,557,600
			% Total Cost	18%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 700,000
2 Site Preparation (debris and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Demolition (concrete structures as encountered)	Lump Sum	$ 100,000	1	$ 100,000
4 Temporary Offices	Month	$ 3,000	31	$ 93,000
5 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
			Subtotal	$ 968,000
			% Total Cost	3%
REMEDIAL COMPONENTS				
Engineered Cap				
1 Excavation of impacted soil from 0-2 feet	Cubic Yard	$ 25	28,244	$ 706,111
2 Construction of Surface Cap, Geotextile, Base, Binder, and Wearing Course	Square Foot	$ 2	381,300	$ 743,535
3 Backfill	Cubic Yard	$ 30	25,420	$ 762,600
			Subtotal	$ 2,212,246
			% Total Cost	7%
Shallow Source Unsaturated Zone Excavation (2-8')				
1 Clear Excavation Area (Sewer line support/relocation)	Acre	$ 7,500	5.23	$ 39,239
2 Relocation of Power Lines other utilities in the remediation area	Lump Sum	$ 400,000	1	$ 400,000
3 Excavation of impacted soils from 2-8 feet	Cubic Yard	$ 25	51,741	$ 1,293,533
4 Backfill	Cubic Yard	$ 30	62,090	$ 1,862,688
			Subtotal	$ 3,595,460
			% Total Cost	12%
Solid Waste Disposal				
1 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
2 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	119,979	$ 7,798,613
			Subtotal	$ 7,947,613
			% Total Cost	26%
NAPL Recovery System				
1 NAPL Recovery and Treatment System - 3 wells	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 100,000
			% Total Cost	0%
Subsurface NAPL Migration Barrier				
1 Jet Grout Wall (120' deep)	Cubic Yard	$ 200	3,333	$ 666,667
2 Soil Bentonite Wall (50' and 70' deep)	Cubic Yard	$ 150	4,000	$ 600,000
2 Wastage Handling and Disposal (25% of walls)	Cubic Yard	$ 80	1,833	$ 146,667
			Subtotal	$ 1,413,333
			% Total Cost	5%
In-situ Stabilization				
1 In-situ Stabilization of Beach Channel Dr & Bulkhead (70' deep)	Cubic Yard	$ 200	-	$ -
2 Wastage Handling and Disposal (25% of volume of wall)	Cubic Yard	$ 80		$ -
			Subtotal	$ -
			% Total Cost	0%
Long-term Monitoring and Reporting Costs				
1 Periodic Monitoring, Reporting, and Maintenance (I=5%)	Year	$ 100,000	30	$ 1,537,245
			Subtotal	$ 1,537,245
			% Total Cost	5%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 22,594,253
Total O & M costs				$ 1,537,245
Total No Contingency Costs				$ 24,131,498
Contingency (25%)				$ 6,032,875
			% TOTAL COSTS	**20%**
			TOTAL COST	**$ 30,164,373**

Table A-4
Detailed Cost Estimate for Remedial Alternative 4
Rockaway Park
Rockaway Park, New York

Remedial Component	Unit	Unit Price	Remedial Alternative 4 Cap, Shallow Source Removal (8'), NAPL Recovery, Barriers (50' and 120'), In-situ Stabilization Quantity	Total Cost
COMMON COST COMPONENTS				
Pre-construction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 600,000	1	$ 600,000
2 Permitting and Regulatory submittals	Lump Sum	$ 100,000	1	$ 100,000
3 Pre-construction Analytical Sampling	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 800,000
			% Total Cost	2%
Construction Management				
1 Construction Oversight	Day	$ 1,920	655	$ 1,257,600
2 Air Monitoring during excavations	Day	$ 960	625	$ 600,000
3 Air Logics Air System	Month	$ 120,000	30	$ 3,600,000
3 Site Survey (Pre-construction and Post-Remediation)	Acre	$ 10,000	10	$ 100,000
			Subtotal	$ 5,557,600
			% Total Cost	12%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 500,000	1	$ 700,000
2 Site Preparation (debris and shrub removal)	Lump Sum	$ 50,000	1	$ 50,000
3 Demolition (concrete structures as encountered)	Lump Sum	$ 100,000	1	$ 100,000
4 Temporary Offices	Month	$ 3,000	31	$ 93,000
5 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
			Subtotal	$ 968,000
			% Total Cost	2%
REMEDIAL COMPONENTS				
Engineered Cap				
1 Excavation of impacted soil from 0-2 feet	Cubic Yard	$ 25	28,244	$ 706,111
2 Construction of Surface Cap, Geotextile, Base, Binder, and Wearing Course	Square Foot	$ 2	381,300	$ 743,535
3 Backfill	Cubic Yard	$ 30	25,420	$ 762,600
			Subtotal	$ 2,212,246
			% Total Cost	5%
Shallow Source Unsaturated Zone Excavation (2-8')				
1 Clear Excavation Area (Sewer line support/relocation)	Acre	$ 7,500	5.23	$ 39,239
2 Relocation of Power Lines other utilities in the remediation area	Lump Sum	$ 400,000	1	$ 400,000
3 Excavation of impacted soils from 2-8 feet	Cubic Yard	$ 25	51,741	$ 1,293,533
4 Backfill	Cubic Yard	$ 30	62,090	$ 1,862,688
			Subtotal	$ 3,595,460
			% Total Cost	8%
Solid Waste Disposal				
1 Disposal Costs and Hauling of Bulky Waste	Ton	$ 149	1,000	$ 149,000
2 Disposal Costs Hauling and Thermal Treatment	Ton	$ 65	119,979	$ 7,798,613
			Subtotal	$ 7,947,613
			% Total Cost	17%
NAPL Recovery System				
1 NAPL Recovery and Treatment System - 3 wells	Lump Sum	$ 100,000	1	$ 100,000
			Subtotal	$ 100,000
			% Total Cost	0%
Subsurface NAPL Migration Barrier				
1 Soil Bentonite Wall (50' deep)	Cubic Yard	$ 150	2,639	$ 395,833
2 Jet Grout Wall (120' deep)	Cubic Yard	$ 200	3,333	$ 666,667
3 Wastage Handling and Disposal (25% of walls)	Cubic Yard	$ 80	1,493	$ 119,444
			Subtotal	$ 1,181,944
			% Total Cost	2%
In-situ Stabilization				
1 In-situ Stabilization of Beach Channel Dr & Bulkhead (70' deep)	Cubic Yard	$ 200	63,356	$ 12,671,296
2 Wastage Handling and Disposal (25% of volume)	Cubic Yards	$ 80	15,839	$ 1,267,130
			Subtotal	$ 13,938,426
			% Total Cost	29%
Long-term Monitoring and Reporting Costs				
1 Periodic Monitoring, Reporting, and Maintenance (I=5%)	Year	$ 100,000	30	$ 1,537,245
			Subtotal	$ 1,537,245
			% Total Cost	3%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 36,301,290
Total O & M costs				$ 1,537,245
Total No Contingency Costs				$ 37,838,535
Contingency (25%)				$ 9,459,634
			% TOTAL COSTS	**20%**
			TOTAL COST	**$ 47,298,169**