CDM

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July 22, 2011

Mr. Lucas Berresford
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Bureau of Land and Waste Management
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Subject: Feasibility Study Report
Former Philip Services Corporation (PSC) Site
Rock Hill, South Carolina

Dear Lucas:

Enclosed are three copies of the finalized Feasibility Study Report for the PSC site. If you have any questions, please give me a call at (404) 720-1400.

Sincerely,

Andrew Romanek

Andrew P. Romanek, P.E., BCEE
Associate
Camp Dresser & McKee Inc.

Enclosure

File: 20958-50105

REPORT

Feasibility Study Report

FORMER PHILIP SERVICES CORPORATION SITE

ROCK HILL, SOUTH CAROLINA

PREPARED FOR: SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONEMTNAL CONTROL

July 2011

CDM

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Executive Summary

This executive summary presents an overview of the feasibility study (FS) conducted for the former Philip Services Corporation (PSC) Site in Rock Hill, South Carolina. The PSC site is located at 2324 Vernsdale Road, approximately 4.5 miles southwest of City of Rock Hill. The site consists of approximately 44.5 acres of industrial property on the west side of Wildcat Creek and approximately 108 acres of undeveloped woodland on the east side of Wildcat Creek.

The PSC site is a former Resource Conservation and Recovery Act (RCRA) hazardous waste treatment, storage, and disposal facility. Operations began at the site in 1966 and continued until the bankruptcy of PSC in December 2003, at which time the South Carolina Department of Health and Environmental Control (SCDHEC) assumed the environmental management responsibilities of the site. Several previous investigations at the site have identified chemical releases to soil and groundwater, and some remediation has been performed.

The results of the remedial investigation (RI) revealed that contaminant migration and fate characteristics are controlled by four dominant hydrogeologic features: saprolite, alluvium, partially weathered rock (PWR), and bedrock. The saprolite contains shallow groundwater. Contaminants present in the saprolite migrate to the alluvium, PWR, and bedrock features. The alluvium is more permeable than the saprolite and exerts a high degree of control over the site hydrogeology. Contaminants migrating to the alluvium are likely diluted by a higher flux of groundwater through this zone before eventually discharging to Wildcat Creek. The configuration of the PWR at the site is highly variable, and groundwater will either migrate from this zone to the alluvium or bedrock. Groundwater in the bedrock is controlled by fractures, and groundwater from this zone migrates to either alluvium deposits or underneath Wildcat Creek.

The results of environmental media sampling during the RI revealed that several chemicals, predominantly volatile organic compounds (VOCs), were detected above regulatory screening criteria in both surface and subsurface soil. Detected concentrations above criteria are limited to four soil focus areas: Warehouse (Drum Storage and Management) Area, Incinerator / Drum Repackaging Area, Solvent Ditch Area, and South Drum Storage Area. The highest concentrations in soil were detected in the Incinerator Area. The presence of several VOCs above EPA Region 9 Soil Screening Levels (SSLs) indicates that ongoing sources of groundwater contamination may be present in these areas.

The groundwater sampling results from the RI were consistent with the soil sampling results. In general, groundwater concentrations were high in areas with high soil concentrations. Several monitoring wells on site, encompassing the warehouse to Wildcat Creek, contain concentrations above EPA Maximum Contaminant Levels. Similar to soil, four focus areas were identified for groundwater based on observed concentrations and potential source areas: Incinerator / Drum Repackaging Area, Solvent Ditch Area, Burn Pits, and Fuel Oil Area.

The human health risk assessment conducted for the RI indicated that site-related environmental contamination posing potential cancer risks and noncancer hazard are related to contaminated groundwater, surface soil, and subsurface soils. The pathways of principal concern are exposure to chlorinated VOCs in groundwater though drinking water ingestion, and inhalation of VOCs in indoor air originating from groundwater. The final chemicals of concern (COCs) in soil related to potential human exposure risks are primarily metals (thallium and vanadium), with chlorinated VOCs limited to subsurface soils in two hot spot locations (RISB-25 and RISB-64)**.** However, 22 additional chemicals were identified as COCs for soil based on SSL exceedances. Twenty-one VOCs along with manganese were identified as COCs in groundwater based on calculated risks as well as a comparison to drinking water standards.

Based on the results of the RI, the following remedial action objectives (RAOs) have been developed:

- Minimize potential for human contact with COCs in soil.
- Minimize future releases of COCs from soil to groundwater and from groundwater to surface water.
- Prevent human exposure to groundwater having concentrations in excess of remedial goals established for the site.
- Meet groundwater remedial goals at monitoring wells (to be established during remedial design) located immediately upgradient of Wildcat Creek.
- Minimize future releases of COCs from soil and groundwater to indoor air.

These RAOs specifically address the highest observed concentrations and calculated risks for the media sampled during the RI. Based on these RAOs, general response actions (GRAs) were identified as the first screening step in determining potential remedial measures that will be applicable for this site. The identified GRAs include no action, institutional controls, containment, removal/extraction, treatment, and disposal/discharge. For each GRA, there are various remediation methods, or technologies, used to carry out the response action. To develop remedial alternatives for this site, the potential technologies and process options for each GRA were screened and evaluated to determine those that should be retained as part of the alternatives development in the FS.

The retained technologies were grouped into six groundwater and six soil alternatives that were carried further into the detailed analysis of the FS. Also evaluated were three alternatives with a combination of both groundwater and soil remedial technologies. The following briefly summarizes each alternative that was evaluated:

Groundwater

1. **No Action** – This alternative does not involve any action beyond reassessments of the site at 5-year intervals. This alternative is required by the National Contingency Plan (NCP), as it serves as a baseline for comparison of other alternatives.

2. **Institutional Controls** – This alternative includes implementing deed restrictions that prevent prolonged exposure to contaminants, control future development, prevent installation of new potable wells, and prevent potable use of groundwater and surface water within the affected area. It also includes implementing a monitoring plan for groundwater and surface water sitewide to evaluate COC concentrations in these media on a routine basis. This monitoring plan includes conducting reassessments of the conditions at the site every five years.

3. **Hydraulic Containment and Onsite Physical/Chemical Treatment** – This alternative includes all of the institutional controls described above. Additionally, it would include collecting groundwater through extraction wells and trenches, and pumping the impacted water to an onsite wastewater treatment system with subsequent discharge to the municipal publicly owned treatment works through an existing industrial discharge permit. Containment would be set up in both regolith (shallow) and bedrock hydraulic zones, with extracted groundwater from both zones being transferred to the existing groundwater treatment system.

4. **Chemical Oxidation, Dual-Phase Extraction, and Bedrock Extraction -** This alternative includes all of the institutional controls described above. Additionally, in situ chemical oxidation would be performed to treat dissolved-phase contaminants in the regolith zone, dual-phase extraction (DPE) to treat free product fuel oil, and bedrock contaminants would be contained and treated using extraction wells and the existing groundwater treatment system.

5. **Air Sparging, Dual-Phase Extraction, and Bedrock Extraction -** This alternative includes all of the institutional controls described above. Additionally, it involves an air sparging system in regolith groundwater to treat the majority of the plume area. As with Alternative 4, this treatment process would be combined with DPE to treat free product fuel oil, which would be completed prior to starting the air sparging system in this area. Finally, bedrock contaminants would be contained and treated using extraction wells and the existing groundwater treatment system.

6. **Permeable Reactive Barrier Wall, Dual-Phase Extraction, and Bedrock Extraction -** This alternative includes all of the institutional controls described above. Additionally, this alternative involves constructing a subsurface permeable reactive barrier (PRB) wall downgradient of the groundwater areas of concern to treat affected groundwater before it continues off site. This treatment process would be combined with DPE to treat free product fuel oil. Bedrock contaminants would be contained and treated using extraction wells and the existing groundwater treatment system.

Soil

1. **No Action** – This alternative does not involve any action beyond reassessments of the site at 5-year intervals. This alternative is required by the NCP, as it serves as a baseline for comparison of other alternatives.

2. **Institutional Controls** – This alternative includes implementing deed restrictions that prevent prolonged exposure to contaminants, control future development, prevent installation of new potable wells, and prevent potable use of groundwater within the affected area; maintaining existing fencing around the industrial property as an additional institutional control to prevent access to potentially hazardous areas; and conducting reassessments of the conditions at the site every five years.

3. **Soil Excavation and Offsite Disposal –** This alternative includes all of the institutional controls described above. Additionally, this alternative consists of excavating impacted material and then transporting this material off site to an appropriate regulated landfill. Soil would be excavated and then loaded onto trucks. The excavated material would then be landfilled in a regulated solid waste landfill, or if the waste is determined to be a hazardous, disposed of in a hazardous waste landfill. Demolition of some buildings would be required with this alternative.

4. **Source Containment -** This alternative also includes all of the components of Alternative 2 described above. Additionally, it includes capping the entire footprint of soil areas of concern (estimated at 7 acres) with a cover that is consistent with the South Carolina closure requirements for municipal solid waste landfills (61-107.258). Demolition of some buildings would be required with this alternative.

5. **Soil Excavation and Onsite Ex Situ Treatment -** This alternative also includes all of the components of Alternative 2 described above. Soil from the soil areas of concern would be excavated and then transported to a central area on site for staging and treatment. Excavation would include removal of soil to the impacted depth above the water table. The excavated material would then be treated and returned to its original location as fill material. Demolition of some buildings would be required with this alternative.

6. **Soil Vapor Extraction (SVE) –** This alternative involves the in situ treatment of affected soils in the soil areas of concern. Organic contaminants within the affected soil would be collected by SVE or thermally enhanced SVE. This alternative also includes all of the components of Alternative 2 described above.

Combination Groundwater and Soil Alternatives

1. **Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced Multi-Phase Extraction (MPE), and Deep Soil Mixing** – This alternative includes institutional controls, hydraulic containment in both the regolith and bedrock zones, excavation and offsite disposal of Principal Threat Source Material (PTSM), metals excavation and disposal, SVE in the Burn Pit Area (if necessary based on additional assessment data to be collected), thermal-enhanced MPE in the Fuel Oil Area, and deep soil mixing with oxidant. For the purposes of this FS, PTSM is defined as any area with VOC soil concentrations exceeding 20 times EPA Toxicity Characteristic Leaching Procedure criteria or that pose an incremental cancer risk of 10^{-3} or greater. Deep soil mixing would be applied in VOC impacted areas in both soil and regolith groundwater.

2. **Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Air Sparging** – This alternative includes institutional controls, hydraulic containment in the bedrock zone, excavation and offsite disposal of PTSM, metals excavation and disposal, SVE in VOC impacted areas, thermal-enhanced MPE in the Fuel Oil Area, and air sparging in VOC impacted areas.

3. **Hydraulic Containment, SVE, Thermal-Enhanced MPE, and In Situ Thermal Treatment –** This alternative includes institutional controls, hydraulic containment in both the regolith and bedrock zones, metals excavation and disposal, SVE in the Burn Pit Area (if necessary based on additional assessment data to be collected), thermal-enhanced MPE in the Fuel Oil Area, and in situ thermal treatment in VOC impacted areas. Under this alternative, in situ thermal treatment would be applied to areas of higher concentrations in both soil and regolith groundwater, approximately defined as 1,000 mg/kg total VOCs in soil and 1,000 ug/L total VOCs in groundwater. The total treatment area is not as large as in situ chemical oxidation, air sparging, and SVE proposed under other alternatives. However, when factoring in expected treatment beyond the direct treatment zone, it covers the areas in soil where VOC remedial goals are exceeded.

Each of the alternatives presented above was carried into the detailed analysis phase of the FS where the alternatives were evaluated on the basis of the threshold and balancing criteria defined in the NCP. These criteria include overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements (ARARs), long-term effectiveness and permanence, reduction of mobility/toxicity/volume through treatment, short-term effectiveness, implementability, cost, state acceptance, and community acceptance. The details regarding how each alternative does or does not meet these criteria is described in the report. Following this evaluation, the alternatives were compared relative to each other using the NCP criteria.

Section 1
Introduction

This report presents the feasibility study (FS) conducted for the former Philip Services Corporation (PSC) Site in Rock Hill, South Carolina. The report includes a screening of remedial action technologies for the site and proposed remedial action alternatives based on the findings of the remedial investigation (RI). The RI and FS have been prepared in general accordance with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR 300]. Although the PSC site is not a National Priority List site under the U.S. Environmental Protection Agency's (EPA's) Superfund program, the RI/FS followed Superfund guidance under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as appropriate.

1.1 Background

The PSC site in Rock Hill, South Carolina is a former Resource Conservation and Recovery Act (RCRA) hazardous waste treatment, storage, and disposal facility. Operations began at the site in 1966 and continued until the bankruptcy of PSC in December 2003, at which time the South Carolina Department of Health and Environmental Control (SCDHEC) assumed the environmental management responsibilities of the site. Several previous investigations at the site have identified chemical releases to soil and groundwater, and some remediation has been performed.

1.2 Purpose

The primary purpose of the FS is to develop and evaluate remedial action alternatives for the site that will be protective of human health and the environment. This objective is accomplished through the following activities:

- Determine Applicable or Relevant and Appropriate Requirements (ARARs).
- Identify the extent of contamination to be addressed.
- Present remedial action objectives.
- Develop remedial goals based on ARARs.
- Identify and screen remedial technologies and process options.
- Develop and analyze remedial action alternatives.

The FS Report will be used to support subsequent decision documents and the implementation of remedial actions at the site.

Section 2
Remedial Investigation Findings

This section summarizes the findings of the RI conducted by Camp Dresser & McKee Inc. (CDM) for the PSC site. More information is available in the Remedial Investigation Report (CDM, September 2008).

2.1 Site Characteristics and Background

2.1.1 Site Description

The PSC site is located at 2324 Vernsdale Road, approximately 4.5 miles southwest of City of Rock Hill in South Carolina. Robertson Road borders the industrial portion of the property to the northeast, and the Norfolk Southern Railroad forms the northwestern boundary. Wildcat and Fishing Creeks border the industrial property on the southeast and southwest, respectively. The site consists of approximately 44.5 acres of industrial property on the west side of Wildcat Creek and approximately 108 acres of undeveloped woodland on the east side of Wildcat Creek. **Figure 2-1** presents a current site plan.

The site is immediately surrounded by undeveloped land and commercial/industrial properties. Osmose Wood Preserving Inc. is located directly across the railroad to the northwest. Low-density residential properties and a high school are located in the vicinity of the site. Higher density residential areas are located to the southeast and northeast, towards the City of Rock Hill.

The site consists of several buildings: a former office on the northern portion of the site close to Robertson Road, a large warehouse building along the northwest portion of the site bordered by the railroad, a wastewater treatment building located in the southwest portion of the site, and several other small buildings across the site. The entire site is secured by fencing west of Wildcat Creek, with one gate located at Robertson Road, a second gate on the southwest portion of the site along Vernsdale Road, and a third gate just west of Wildcat Creek.

2.1.2 Topography and Drainage

The PSC site is located in the Piedmont Physiographic Province of South Carolina. This province is characterized by gently rolling hills and ridges intersected by stream and river valleys. Within the vicinity of the site, land surface elevations range from about 650 feet east of the site down to about 480 feet on Fishing Creek south of the site. Elevations on the site average from about 510 feet to 530 feet. The surface drainage basin for the site vicinity covers approximately 55 acres including the site and areas to the east.

Two surface water features are adjacent to the site. Fishing Creek flows from the northwest to form the south boundary of the site and continues to flow to the south downstream of the site. Wildcat Creek flows from the north to form the east boundary of the operations area of the former facility. Wildcat Creek flows into Fishing Creek along the south boundary of the site. Most surface drainage from the operations area of the former facility is directed to the east into Wildcat Creek through several stormwater outfalls. One stormwater outfall also directs surface runoff from the southwest corner of the former operations area to Fishing Creek.

2.1.3 Hydrogeology

The geology of the Piedmont Physiographic Province includes crystalline bedrock of metamorphic and igneous origin. The metamorphic rocks range from coarsely-crystalline, weather-resistant gneiss to easily weathered mica schist and the finer-grained form called phyllite. Igneous rock, referred to as gabbro, exists beneath the site. Gabbro is a crystalline rock that is dark in color and contains minerals that are moderately susceptible to weathering processes. It is probable that this gabbro has been subjected to some degree of metamorphism and may be more appropriately classified as a meta-gabbro. Although the mineral composition may not be significantly altered by the regional metamorphism, it could have imparted structural changes in the rock such as the development of regional fracture systems. If regional metamorphism has not affected the rock, stress-relief fractures are expected in this unaltered rock type.

The regional nomenclature applied to aquifer systems in the Piedmont Physiographic Province is to classify the system as the Piedmont Aquifer regardless of the depth zone. Groundwater in the Piedmont Aquifer systems typically occurs in three zones of interest. In descending order these zones include the regolith zone, the transition zone between bedrock and the regolith, and the bedrock zone. These zones are discussed below along site-specific details reported during the RI.

2.1.3.1 Regolith Zone

The regolith zone at the site consists primarily of saprolite, the unconsolidated weathering product of the underlying parent rock that retains the relic structure of the parent rock. The regolith zone also includes the recent stream alluvium deposits associated with Fishing Creek and Wildcat Creek. The regolith thickness at the site ranges from 15 feet to 35 feet. The saprolite and the alluvium are fully connected hydraulically and behave as a single groundwater zone. However, the permeability of the alluvium (primarily sand and gravel with silt) is higher than the permeability of the saprolite (primarily silt with a lower percentage of sand and clay size materials). The depth to groundwater in the regolith measured at the site ranges from 5 feet near the streams to 20 feet at the higher elevations.

Groundwater flow in the regolith zone is from areas of topographic highs to areas of topographic lows. Recharge to this zone occurs at all elevations from precipitation, and this recharge represents a driving force for groundwater flow. Where the land surface intersects the elevation of the saturated zone in the regolith (such as along streams), groundwater discharge occurs creating a groundwater migration pattern toward the nearest surface stream. Some quantity of groundwater in the regolith zone also migrates downward to recharge the transition zone and the bedrock zone.

CDM applied two methods to estimate the groundwater flux passing downgradient of the site under natural conditions. The first method applied was based on the annual precipitation infiltration rate within the site groundwater basin. The second method was based on calculations using hydrogeologic data collected during the RI. The calculations, supporting data, and assumptions are provided below:

<u>Infiltration Method</u>

$$Q = I_v$$

$$I_v = (A_{db\text{-}uncovered} \times I_{r\text{-}uncovered}) + (A_{db\text{-}covered} \times I_{r\text{-}covered})$$
$$= (1{,}069{,}000\ ft^2/yr \times 1.31\ ft/yr) + (244{,}650\ ft^2/yr \times 0.033\ ft/yr)$$
$$= 1{,}408{,}463\ ft^3/yr \text{ or } 20\ gpm$$

Where:

Q	=	Groundwater flux
I_v	=	Groundwater basin infiltration volume
$A_{db\text{-}uncovered}$	=	Uncovered groundwater basin surface area
$A_{db\text{-}covered}$	=	Covered groundwater basin surface area
$I_{r\text{-}uncovered}$	=	Uncovered area infiltration rate
$I_{r\text{-}covered}$	=	Covered area infiltration rate

The infiltration rates for the covered and uncovered areas were provided by SCDHEC and were also used to develop the SSLs. The total area of the groundwater drainage basin was determined from the topographic map and is approximately 30 acres. The covered portion of this area was estimated from the surface areas within the groundwater drainage basin that are covered by buildings and pavement. This portion is approximately 5.6 acres and includes the facilities located upgradient of the site.

<u>Hydrogeologic Calculations</u>

$$Q = T \times i \times L$$

Where:

T	=	Transmissivity of saprolite/partially-weathered rock
i	=	Hydraulic gradient
L	=	Discharge face perpendicular to groundwater flow direction = 1,100 feet

The groundwater flux was calculated using the equation above for the partially-weathered rock (PWR) and saprolite combined. T values were estimated during the RI by pumping tests at six wells completed in the PWR and saprolite zones. CDM developed a range of T values for the combined PWR and saprolite by first discarding the highest and lowest T values and calculating a mean of 220 ft^2/day from the remainder. An upper bound for T of 500 ft^2/day was calculated using the 95% upper confidence limit of the mean. A range of *i* values was also calculated from the saprolite potentiometric surface map in the RI report. The high value of 0.01 ft/ft was calculated from the south portion of the site from RIMW-1 through RIMW-10 down to the 507.5-foot contour. The low value of 0.008 ft/ft was calculated from the north portion of the site from BP-1A through RIMW-6 up to the 512-foot contour. The length of the discharged face was estimated based on the width of the groundwater plume at 1,000 feet. The range of estimated groundwater flux values was from 9 gpm to 26 gpm.

The saprolite zone includes all identified potential source areas. As a result, the vadose zone of the saprolite is important to contaminant loading to groundwater in addition to direct contact exposures. In western portions of the site, the water table does not reside in saprolite, and the vadose zone extends into the underlying transition zone. Volatile organic compounds (VOCs) occur in groundwater and in the vadose zone, and extraction well performance in this zone exhibits a relatively small area of groundwater capture. Based on visual observation, well performance tests, and monitor well purging, the saprolite zone is relatively low in transmissivity. Groundwater migrating in the saprolite flows toward Wildcat Creek where it is intercepted by the more permeable stream alluvium. Ultimately, this groundwater discharges to Wildcat Creek from the alluvium. Otherwise, groundwater in the saprolite provides localized recharge to the underlying transition and bedrock zones.

Source areas were not identified by the RI in the alluvium with the exception of the fuel oil area. Because the alluvium is more permeable than the saprolite, and likely more permeable than the transition zone and bedrock, this feature exerts a high degree of control over the site groundwater flow regime. In general, groundwater migrates into the alluvium from saprolite, the transition zone, and bedrock from the west portion of the site. Once in the alluvium, the contaminant concentrations are diluted by the higher flux of groundwater through the alluvium as compared to the adjacent zones. Groundwater in the alluvium ultimately discharges to Wildcat Creek. However, contaminants may spread throughout the alluvium while migrating in the downstream direction before actually discharging to Wildcat Creek. Sampling during the RI concluded that Wildcat Creek does not contain detectable levels of constituents.

Groundwater flow from the alluvium and into the saprolite likely occurs in response to pumping from the saprolite. Based on the water table surface and bedrock surface mapping, and the results of the aquifer performance testing, it is probable that the groundwater being collected by the existing extraction wells is derived from both the alluvium and Wildcat Creek.

2.1.3.2 Transition Zone

The transition zone between the regolith and bedrock zones consists of partially weathered bedrock and primarily of rock fragments, boulder-size rocks, and fractured bedrock that is in full hydraulic connection with the overlying regolith zone. The total groundwater flow volume estimate of 20 gpm for the site includes groundwater flowing through the transition zone.

Groundwater flow in the transition zone follows similar patterns to the regolith zone. However, because of groundwater flow through fractures, the flow path of least resistance may differ in this zone, and the permeability is typically higher than in saprolite. Some quantity of groundwater in the transition zone migrates downward to recharge the bedrock zone. Lateral groundwater flow in the transition zone is toward discharge points such as streams. Groundwater in the transition zone may migrate in the downstream direction of stream flow before the vertical gradient effectively causes it to discharge.

The surface elevation and thickness of the transition zone is highly variable. The hydraulic testing also indicates that the transmissivity of the transition zone is highly variable. This is to be expected as the degree of fracturing of the parent rock and nature of the weathered by products of the rock are highly variable. The transition zone and regolith represent a common hydrogeologic zone with groundwater migrating within each unimpeded, but at different rates. Groundwater in the transition zone not migrating into the alluvium at the site recharges the bedrock. This appears to be the case in the western portions of the site.

2.1.3.3 Bedrock Zone

Groundwater in the gabbro bedrock beneath the site occurs in the primary pore space of the rock and in fractures developed in the rock. The primary porosity of the gabbro is likely very low and not significant for groundwater migration. However, the primary porosity may contain site-related constituents that could be slowly released into fractures, resulting in low concentrations of site-related constituents in groundwater migrating through the fractures for an indeterminate period of time.

Groundwater occurrence and migration in the bedrock is controlled by fractures. Small-scale fractures occurred at many investigation locations while very little fracturing was evident at others. The location of RIMW-22 provides an exception to the relatively low fracture density at the site. The relatively thick sequence of the transition zone and frequent fracturing in the bedrock indicate that this location could supply a relatively large quantity of groundwater to an extraction well as compared to the existing extraction wells that produce about 3 gpm. The lateral extent of this fracture zone was not determined in detail during the RI, but if the fracture zone represents a linear feature across the site, it may allow an opportunity to gain a high degree of hydraulic control. Three wells (RIMW-20, RIMW-21, and RIMW-30) in the vicinity of RIMW-22 also revealed significant fracturing and weathering.

Groundwater migration in the bedrock follows the same general rules as the other two zones and migrates from topographic high areas of recharge to topographic low areas of discharge such as streams. However, features of a more regional scale, such as major drainage basin divides and rivers, rather than features of a site-specific scale, such as Wildcat Creek, may influence groundwater flow patterns in deep bedrock. Furthermore, the groundwater flow paths of least resistance in the bedrock zone are along fractures.

The potentiometric surface mapped for bedrock and the observation well responses during the aquifer performance tests (APTs) indicate the possibility for two preferential flow zones in the bedrock. One of these flow zones exists in the vicinity of EW-2 and extends northeast into the alluvial deposits at RIPZ-3. A second may also exist in a nearly parallel orientation to the north in the vicinity south of RIMW-22 and leading into the alluvium toward MW-121B. However, the evidence for this feature is not as conclusive because the APT results did not provide information in this area. Interceding between these two possible preferential flow zones are several bedrock monitor wells that exhibit very low transmissive conditions (as observed during development and purging). In any case, groundwater in the bedrock horizon migrates into the alluvium deposits and subsequently discharges to Wildcat Creek. However, some bedrock groundwater also appears to migrate underneath Wildcat Creek, as evidenced by the concentrations detected in bedrock well MW-121B across the creek.

2.1.4 Site History

The PSC Site is a former hazardous waste transportation, storage, and disposal facility. In 1966, Quality Drum Company and Industrial Chemical Company began operations consisting of waste storage, treatment, and recycling. The facility received spent solvents from offsite facilities, stored the solvents on the site in drums and tanks, and recovered these solvents through distillation. Until 1980, wastes from the distillation process (e.g., still bottoms) were sent to a local landfill. In 1980, a hazardous waste incinerator was installed for still bottoms treatment.

In May 1983, Stablex Inc. acquired the facility. At that time, approximately 26,000 drums and 200,000 gallons of bulk liquid waste stored in tanks were present on the site. In 1986, ownership of the property was transferred to NUKEM, who changed the facility name to ThermalKEM in 1987. ThermalKEM operated as a hazardous waste incinerator and storage facility under RCRA interim status (EPA I.D. No. SCD 044 442 333). PSC took over operation and management of the facility in November 1995 and ceased operation of the incinerator one month later. SCDHEC assumed the environmental management responsibilities following the bankruptcy of PSC in December 2003.

Through the years of operation, the facility has sustained two large structural fires. The facility also experienced a subsurface diesel fuel release, with the quantity of fuel spilled estimated to be greater than 200,000 gallons. Based on several investigations and groundwater sampling, an extraction and treatment system was installed in 1988. Additional extraction components (groundwater extraction wells EW-2 and EW-3 and a fuel interceptor trench) were installed in the mid 1990s.

The incinerator was dismantled after it was shutdown, and a pit was excavated into soil beneath its footprint to remove contaminated soil. This work was performed prior to SCDHEC management of the site. In 2004, the excavated pit was backfilled and the incinerator building was demolished under the direction of SCDHEC. Upgrades to the treatment system were also completed in 2005.

2.1.5 Site Areas of Concern

Through the RCRA Part B Permit Corrective Action process at the PSC site, four solid waste management units (SWMUs) and seven areas of concern (AOCs) were identified and included in the permit. These SWMUs and AOCs are graphically shown on **Figure 2-2** The SWMUs and AOCs, as listed in the RCRA Facility Investigation (RFI) Part 1 Report (Philip, 1999), and a brief description of the wastes managed/disposed in each area are presented below. Additional information is also presented in the Environmental Data Review and Current Environmental Conditions Report prepared by URS Corporation (March 2006).

- ***Incinerator Building Sump (SWMU 8)*** – contained incinerator ash and water from the incinerator water seals. The incinerator was operated from 1981 to 1995.

- ***Container Storage Area (SWMU 11)*** – large drum storage area on ground surface containing drums of spent halogenated and non-halogenated solvents. This location was used for container storage from pre-1983 until 1995.

- ***Truck Washing Station and Sump (SWMU 19)*** – wastes managed included wash water, residue, and soil from trucks carrying spent halogenated and non-halogenated solvents. The truck washing station/sump was operated from 1981 until 1995.

- ***Burn Pits (SWMU 41)*** – previous disposal area of solvent distillation still bottoms by open pit burning. The burn pits were operated approximately between 1966 and the early 1970's. Impacted soil, drums, and waste material were excavated in this area to a depth of 8 feet in 1985 under supervision of SCDHEC.

- ***Solvent Ditch Area of Concern*** – spill and leakage from tank trucks and the tank farm migrated to this area via stormwater runoff. This ditch was operated from the 1960's until 1983. Soil excavation was performed to remove visibly impacted material in 1983.

- ***Fuel Oil Area of Concern*** – suspected diesel fuel leaks from underground piping associated with three underground storage tanks and from diesel fuel delivery piping to the incinerator.

- ***Drum Repacking Area Fire Area of Concern*** – this building housed spent halogenated and non-halogenated solvents in lab pack form and drums of solids and sludges from spent solvents. The building was destroyed by fire in 1995 and rebuilt the same year.

- ***Blend Tank Overflow Area of Concern*** – tank farm where liquids containing spent halogenated and non-halogenated solvents were blended for incineration prior to 1995.

- ***Scrubber Containment Overflow Area of Concern*** – wastes managed at this location included caustic solutions of scrubber water with particulate matter from incineration.

- ***Boiler Explosion Area of Concern*** – the boiler was used as a backup steam supply for the scrubber and was replaced after it exploded in March 1991. No wastes were managed here but approximately 50 gallons of diesel fuel would have exploded with this boiler.

- ***Stormwater Outflows Areas of Concern*** – collection and outflow areas for stormwater runoff from the site and treatment, storage, and disposal areas.

These SWMUs and AOCs are described further in the RFI Part 1 Report. Figure 2-2 also identifies additional areas of concern for this RI/FS, including the Stablex Materials Area, other drum storage and management areas, and a stormwater pond. The Stablex Materials Area was identified by SCDHEC in historical photographs, and a geophysical survey conducted by SCDHEC indicated that there were subsurface anomalies in the area. While the Stablex Materials Area was planned for use as a disposal area, it is unknown whether any wastes were deposited there.

2.2 Nature and Extent of Contamination

The RI activities at the site included sampling of various environmental media to determine the nature and extent of contamination. Specifically, CDM sampled groundwater, surface water, and sediment from the creeks and soil. The sampling results for these media are summarized below.

Three classes of VOCs and their typical degradation products were identified as having the highest concentrations in both soil and groundwater site wide. Although other compounds were detected on site, they were generally coupled with higher concentrations of compounds from one of the three identified classes shown below.

- BTEX – Benzene, toluene, ethylbenzene, and xylene.

- Chlorinated ethenes and ethanes (CEE)– Chloroethane; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; cis-1,2-dichloroethene; 1,1,2,2-

tetrachloroethane; tetrachloroethene; 1,1,1-trichloroethane; trichloroethene; 1,1,2-trichloroethane; and vinyl chloride.

- Chlorinated benzenes (CB)– Chlorobenzene; 1,2-dichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene; 1,2,3-trichlorobenzene; and 1,2,4-trichlorobenzene.

2.2.1 Soil

Soil samples were compared with EPA Region 9 Preliminary Remedial Goals (PRGs) for industrial soil and/or EPA Region 9 Soil Screening Levels (SSLs) with a dilution-attenuation factor (DAF) of 20 in the RI report. Surface soil sampling results revealed concentrations exceed the EPA Region 9 PRGs for industrial soil and/or EPA Region 9 SSLs for all three of the VOC classes identified above. The highest concentrations of these compounds were primarily confined to four areas of the site: North Drum Storage Area, Solvent Ditch Area, Incinerator/Drum Repackaging Area, and South Drum Storage Area. The four areas shown on **Figure 2-3** were estimated based on the extent of SSL exceedances with a DAF of 20, and are summarized below:

- Soil Area #1 – Warehouse (Drum Storage and Management) Area. This area is located on the northern end of the warehouse and contains the former East Drum Storage, Drum Receiving, and Drum Packaging areas. Only CEE compounds were detected above SSL/PRG screening criteria in this area.

- Soil Area #2 - Incinerator /Drum Repackaging Area. This area contains both the southern end of the warehouse (Drum Repackaging and Fire area) and the former incinerator area southeast of the warehouse. BTEX, CB, and CEE compounds were all detected above screening criteria in this area. Site wide, the highest concentrations were detected in this area for all three VOC classes.

- Soil Area #3 – Solvent Ditch Area. This area contains the former solvent ditch area. This area is also located southeast of the former Blend Tanks Overflow area. BTEX and CEE compounds were detected above screening criteria in this area.

- Soil Area #4 – South Drum Storage Area. This area is the furthest southeast on the site and although this area does not include any previously identified SWMUs, it is adjacent to the former stormwater pond and a former drum storage area. BTEX and CEE compounds were detected above screening criteria in this area.

Within these areas, the Incinerator Area had the highest concentrations of all three classes of compounds. The South Drum Storage Area had the lowest average concentrations in surface soil. Subsurface soil sampling results revealed that concentrations also exceed industrial soil PRGs and/or SSLs in the subsurface of the four identified areas. The detected concentrations were generally higher than surface soil in all four areas, and in some cases, exceeded surface soil detections by ten times. Subsurface samples also contained detections of the three VOC classes below the water table in each area.

The presence of several VOCs above SSLs in each soil focus area indicates that ongoing sources of groundwater contamination may exist in these areas. These potential sources are likely isolated to portions of each area.

2.2.2 Groundwater

Based on information derived from the hydrogeology and concentration contour maps prepared during the RI, groundwater areas (GW Areas) of concern were identified. These areas of concern are shown on **Figure 2-4** and include the following:

- GW Area #1 - Incinerator / Drum Repackaging Area – The incinerator area was chosen because this is the area in regolith (shallow) groundwater and soil with the highest concentrations of CB. This area also includes the southern end of the warehouse where soil concentrations of BTEX exceed 1,000 mg/kg and total CEE soil concentrations are close to 300 mg/kg.

- GW Area #2 - Solvent Ditch Area – Groundwater in the solvent ditch area contains the highest concentrations of chlorinated ethenes in regolith, and the highest concentrations of all three VOC classes were detected in bedrock in this area. This area extends into the North Drum Storage location because detected compounds in groundwater there are consistent with concentrations in the solvent area, possibly indicating one source or contiguous sources.

- GW Area #3 - Burn Pits – Although a removal action previously occurred in this area in 1983, groundwater concentrations in this area do not suggest that VOCs in this area are a result of migration from other areas.

- GW Area #4 - Fuel Oil Area – The fuel oil area remains an area of concern because free product is still present in this location.

The groundwater sampling results for the RI were consistent with the observed soil sampling results. In the areas with the highest concentrations of VOCs in soil, groundwater concentrations were comparably high. Two additional areas of concern exist for groundwater: the former Burn Pit Area and the Fuel Oil Area. Soil concentrations may not be as high in these areas because soil excavation was previously performed in the burn pit area and because the fuel oil product is in the subsurface. The fuel oil product is associated with a former underground leak, meaning that the oil did not have to migrate through a large depth of soil to reach the groundwater.

Regolith groundwater concentrations are highest in the Solvent Area for BTEX and CEE. Concentrations are above EPA maximum contaminant levels (MCLs) throughout a large part of the site from the warehouse building to Wildcat Creek, although no constituents were detected in regolith groundwater on the other side of the creek. CB concentrations are highest in the Incinerator Area, and this plume is not as large as that for the other two VOC classes.

Bedrock groundwater concentrations for BTEX and chlorinated benzenes are highest in the Solvent Ditch area, but the plume size is smaller than in regolith. The CEE concentrations are also highest in the Solvent Ditch area, but concentrations are also high in the Burn Pit area. CEE concentrations appear from the west boundary of the site to Wildcat Creek, and concentrations were detected above MCLs in one well across the creek.

Groundwater concentrations are likely to be from the primary areas of concern identified for soil, and it is believed that there are plumes originating from the Solvent Ditch area, Drum Management Area, Incinerator Area, North Drum Storage Area (although co-mingled with the Solvent Ditch area), Burn Pit Area, and Fuel Oil Area. The only soil area of concern that does not correspond to higher concentrations in groundwater is the South Drum Storage Area.

2.2.3 Creek Sediment and Surface Soil across Creek

Sediment sample results from Wildcat Creek and Fishing Creek, and surface soil sample results from across Wildcat Creek, revealed that although some compounds were detected above laboratory quantitation limits, the results were either below regulatory criteria or were consistent with concentrations detected in the background samples. In addition, compounds detected were not consistent with compounds identified to be constituents of concern in the industrial portion of the PSC site.

2.2.4 Surface Water

The RI did not include surface water sampling because an extensive surface water investigation was previously completed in 2004 by CDM and SCDHEC and revealed minimal surface water impacts. That investigation included installing vapor diffusion modules in Fishing and Wildcat Creeks and performing onsite screening using a portable gas chromatograph. The investigation also included collecting surface water samples for offsite laboratory analyses. Limited impacts were observed in the onsite screening and no organics were detected in the laboratory surface water samples. Additional details can be found in the *Summary Report – Initial Site Investigation* (CDM, October 2004).

2.3 Synopsis of Risk Assessment Results

The human health risk assessment (HHRA) performed for the PSC site as part of the RI addressed potential hazards to human health posed by contaminated media at the site in the absence of any remedial actions. Data collected for the media of concern (groundwater, surface and subsurface soils) were used to quantify potential risk geographically across the site. The site conceptual model identified the following potential receptors for the site:

- Current O&M workers.
- Current and future trespassers.
- Current and future recreational visitors.
- Future excavation workers.
- Future industrial workers.
- Future site residents.
- Future site workers.

The potentially complete exposure pathways are:

- Inadvertent ingestion of soil.
- Dermal contact with soil.
- Inhalation of soil vapor.
- Inhalation of fugitive dust.
- Inhalation of groundwater vapors in indoor air.
- Ingestion of groundwater.
- Dermal contact with groundwater.
- Dermal contact with vapors in indoor air.

Chemicals of potential concern (COPCs) were chosen for use in this risk assessment if their maximum detected concentration exceeded their respective screening levels. Screening levels were taken from EPA Region 9 PRGs for residential soil and tap water (EPA 2004b), using a target cancer risk of 10^{-6} (one in one million) and a target hazard quotient of 0.1. However it should be noted that risk-based screening levels are not available for all chemicals in all media.

The potential for noncancer health hazards was evaluated by comparing average daily doses (ADDs) with reference doses applicable for chronic (long-term) and subchronic (shorter-term) exposure. This ratio of exposure to toxicity is referred to as a hazard quotient (HQ). A hazard index (HI) is the sum of HQs from individual chemicals. An EPA-derived reference dose or concentration defines an ADD below which it is unlikely even for sensitive populations to experience adverse health effects. Thus, if an HI exceeds unity (1), the ADD is higher than a "safe" exposure level and some concern for potential noncancer effects exists. An HI is not, however, an expression of probability of noncancer effects occurring. Generally, the greater the HI above unity, the greater the level of concern. HQs are typically only added together to estimate HIs for chemicals that affect the same target organ(s) or tissue(s).

Cancer risks were estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The upper-bound excess lifetime cancer risk (ELCR) is estimated by multiplying the lifetime average daily dose by an appropriate cancer slope factor. ELCRs are generally expressed in scientific notation as incremental probabilities. An ELCR of 1×10^{-6} (1 in 1,000,000), for example, represents the incremental probability that an individual will develop cancer as a result of exposure to a carcinogenic chemical over a 70-year lifetime under specified exposure conditions. This increment is in addition to the risk of developing cancer from causes unrelated to the exposure. Typical cancer rates in the United States are in the range of 1 in 4 to 1 in 2.

Generally, EPA uses a target cancer risk range of 10^{-6} to 10^{-4} (1 in 1,000,000 to 1 in 10,000) to evaluate the need for remediation or mitigation at a site. Cancer risks below 1 in 1,000,000 are typically assumed to be *de minimis* and would require no remediation or mitigation. Decisions on whether to remediate or mitigate risk for risks that fall in this range are made on a site-specific basis. Risks that exceed 1 in 10,000 often require remediation and/or mitigation; however, no "bright line" has been established at the upper end of the risk range, and, again, risk management decisions are made on a site-by-site basis. SCDHEC's policy is to use 10^{-6} as the basis for whether a risk is acceptable or unacceptable.

Estimates of cancer risk and hazard indices were compared to the above targets to put the magnitude of cancer risks and noncancer hazards into perspective for the risk manager. Potential risks were estimated for each area of concern in soil and groundwater for applicable receptors for each COPC, as shown in **Table 2-1**. Detailed estimates of total cancer and noncancer hazards by exposure route and medium can be found in the RI.

The results of the HHRA risk characterization were used to identify the final constituents of concern (COCs) for the site. In accordance with EPA Region 4 guidance, COCs are those COPCs that either exceed a 1×10^{-4} cumulative cancer risk or exceed a noncarcinogenic hazard quotient of unity. In accordance with EPA Region 4 guidance, in addition to those chemicals that exceed calculated risk levels, any chemicals that exceed ARARs are also considered COCs. Any COPC in groundwater that exceeds state or federal MCLs is considered a COC. Per SCDHEC guidance, chemicals that exceed SSLs are also considered COCs. **Figure 2-5** outlines the COPC and COC development process.

The COCs as presented in the RI were developed based on a DAF of 20. As part of the FS, SCDHEC performed an analysis of site-specific DAFs and calculated a DAF of 7 for uncovered soils and 103.3 for covered soils. An updated COC list based on these changes is presented in **Table 2-2**.

Section 3
Remedial Action Objectives and Goals

Remedial action objectives (RAOs) are designed to meet regulatory requirements and to protect human health and the environment. The RAOs presented in this FS are established to protect human health and the environment by considering the nature and extent of contamination, the potential exposure pathways, and the location and sensitivity of potential receptors. Based on the results of the RI (CDM, September 2008), the following RAOs have been developed:

- Minimize potential for human contact with COCs in soil.
- Minimize future releases of COCs from soil to groundwater and from groundwater to surface water.
- Prevent human exposure to groundwater having concentrations in excess of remedial goals established for the site.
- Meet groundwater remedial goals at monitoring wells (to be established during remedial design) located immediately upgradient of Wildcat Creek.
- Restore groundwater to drinking water standards.
- Minimize future releases of COCs from soil and groundwater to indoor air.

These RAOs specifically address the highest observed concentrations and calculated risks for the media sampled during the RI.

3.1 Applicable or Relevant and Appropriate Requirements (ARARs)

In the process of developing specific remedial goals that will be used to achieve the RAOs, consideration must be given to ARARs. Applicable requirements are those laws or regulations that specifically apply to the hazardous substance, location, or contemplated remedial action for the site. Relevant and appropriate requirements are laws or regulations that address problems or situations sufficiently similar to those encountered at the site, so that their use is well suited to the site but for which the jurisdictional prerequisites have not been met. The chemical-specific ARARs, action-specific ARARs, and location-specific ARARs applicable to the PSC site are presented in the following sections.

3.1.1 Chemical-Specific ARARs

The chemical-specific ARARs include those laws and regulations governing the release of materials possessing certain chemical or physical characteristics, or containing specified chemical compounds (EPA, 1988). These requirements generally set health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, contaminants, and pollutants. Examples include drinking water standards or ambient air quality standards. Laws and regulations that should be considered in developing numeric, chemical-specific ARARs are identified for the site media of concern (soil and groundwater) in **Table 3-1**.

3.1.2 Action-Specific ARARs

Action-specific ARARs are technology-based requirements, establishing performance, design, or other similar action-specific controls or regulations on activities related to the management of hazardous substances or pollutants (EPA, 1988). An example of an action-specific ARAR would be RCRA incineration regulations. Potential action-specific ARARs are presented in **Table 3-2**.

3.1.3 Location-Specific ARARs

Location-specific ARARs are design requirements or activity restrictions based on the geographical or physical position of the site and its surrounding area. Examples include restrictions due to site characteristics, such as floodplains, wetlands, or historic sites. Potential location-specific ARARs for the site are listed in **Table 3-3**.

3.1.4 Other Requirements to be Considered

These requirements pertain to federal and state criteria, advisories, guidelines, or proposed standards that are not generally enforceable but are advisory and that do not have the status of potential ARARs. Guidance documents or advisories "to be considered" in determining the necessary level of remediation for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to be protective.

3.1.5 Waivers

The NCP specifies situations under which the ARARs may be waived [40 CFR 300.430: Remedial Investigation/Feasibility Study (f) Selection of Remedy]. The situations eligible for waivers include:

- The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement.
- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.
- Compliance with the requirement is technically impracticable from an engineering perspective.

- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach.

- With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances for other remedial actions within the state.

- For Superfund-financed response actions only, an alternative that attains the ARAR but does not provide a balance between the need for protection of human health and the environment at the site and the availability of Superfund monies to respond to other sites that may present a threat to human health and the environment.

Where remedial actions are selected that do not attain ARARs, the lead agency must publish an explanation in terms of these waivers. It should be noted that the "fund balancing waiver" only applies to Superfund-financed remedial actions. The PSC site is not a fund led site.

ARARs apply to actions or conditions located on site and off site. Onsite actions implemented under CERCLA are exempt from administrative requirements of federal and state regulations, such as permits, as long as the substantive requirements of the ARARs are met. Offsite actions are subject to the full requirements of the applicable standards or regulations, including all administrative and procedural requirements.

Based on the CERCLA statutory requirements, the remedial actions developed in this FS will be analyzed for compliance with federal and state environmental regulations. This process involves the initial identification of potential requirements, the evaluation of the potential requirements for applicability or relevance and appropriateness, and finally a determination of the ability of the remedial alternatives to achieve the ARARs.

3.2 Remediation Goals

Human health risk assessments were performed as part of the RI to evaluate potential impacts to human health and the environment from hazardous substances associated with the site. A summary of the results of the assessments is provided in Section 2.3. Based on the results of the risk assessment and the overall objectives for remediation, specific remediation goals can be developed. This section presents a discussion of remedial goals that considers human health-based RAOs, as well as ARARs such as National Primary Drinking Water Standards.

3.2.1 Human Health-Based Considerations

The remediation goals and selected remedial action alternative for this site will need to address both the identified carcinogenic risks and non-carcinogenic hazards for human health. A summary of carcinogenic risks and non-carcinogenic hazards were summarized in Table 2-1. Each of these risks that exceed acceptable cancer or non-cancer ranges will be addressed in this FS.

3.2.2 Establishment of Remedial Goals

The proposed remedial goals (RGs) for protection of human health are identified for groundwater and soil in **Table 3-4** and **Table 3-5**, respectively. The RGs are based on those compounds that have been identified as COCs and/or detected above an ARAR in a particular medium. No RGs are presented for sediment or surface water since significant concentrations of contaminants above regulatory criteria are not present for these media.

Figure 3-1 presents a flowchart showing how RGs were developed. In the absence of available state regulatory criteria, PRGs for industrial soil are proposed as RGs for metals in soil, and SSLs are proposed as RGs for VOCs in soil. As described in Section 2, COPCs for soil were initially developed by comparing to residential standards. Industrial PRGs are proposed for metals because the possibility of future development of this site for residential purposes is low and because the primary risks at this site are related to exposure to VOCs. Extending remediation boundaries because of metals exceedances in surface and subsurface soil is expected to have limited value compared to efforts focused on VOC impacted areas.

Additionally, metals contamination has not been observed in groundwater. Thus, SSLs were not proposed for select metals (e.g., arsenic, barium, chromium, nickel, and selenium) even though maximum detected concentrations of these metals exceeded the SSLs. However, RGs were established for three soil COCs (iron, manganese, and vanadium) that were below industrial PRGs and SSLs. These COCs were identified as potential human health hazards during the risk assessment.

For groundwater, EPA MCLs and action levels are proposed as RGs. An RG was also established for chloroethane, which was below its tap water PRG. This additional RG was established because chloroethane was identified as potential human health hazard during the risk assessment.

A groundwater RG was not established for manganese even though it had been identified as a COC. Manganese is a common, non-toxic chemical for which EPA has only established a secondary drinking water regulation. Secondary regulations are for guidance and are not enforceable standards.

Section 4
Identification, Screening, and Evaluation of Technologies and Process Options

This section presents the identification and screening of technology types and process options applicable for remediation of contaminated media at the PSC site. The screening of technologies and development of alternatives address the media of concern (groundwater and soil) for the site and the final list of COCs.

The identification and screening of technologies and process options for this feasibility study occur in three steps: identification of general response actions (GRAs), preliminary screening of technologies and process options, and evaluation of retained technologies and process options. These steps are outlined in the following sections.

4.1 General Response Actions

GRAs are those actions that singly, or in combination, satisfy the RAOs for the identified media by reducing the concentration of hazardous substances or reducing the likelihood of contact with hazardous substances. GRAs are identified based on the established RAOs, site conditions, waste characteristics, and anticipated volume of contaminated media requiring remediation. The GRAs appropriate for addressing contamination at this site are summarized below.

No Action

The no action response is identified for the purposes of establishing a baseline against which other GRAs are compared. There would not be any preventive or remedial actions implemented as a result of the no action response. However, in accordance with CERCLA Section 121(c), as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), a review/reassessment of the conditions at the site is required at 5-year intervals to determine if other remedial action efforts are warranted.

Institutional Controls

Institutional controls are limited actions implemented to reduce the potential for human exposure to contaminants. Institutional controls may be physical, such as fences, barriers, or warning signs; or legal, including relocation, zoning, security-restricted access, deed restrictions or notices upon resale or transfer of title, and notices given to current or prospective owners or renters. Extended monitoring is also considered an institutional control.

Like the no-action response, these actions would not reduce contaminant concentrations. However, institutional actions may be appropriate at sites where land use can be controlled or the contaminants are immobile. Institutional controls can be an effective means for controlling access and therefore reducing risk.

Containment
Containment consists of constructing physical barriers to prevent human contact with contaminated material and to minimize migration of contaminants. Common containment options include capping contaminated areas and constructing vertical barriers. Containment is used to isolate the contaminated media and to restrict migration of the contaminants via soil, water, or air pathways.

Removal/Extraction
Removal involves physically removing contaminated media from a site. Removal generally refers to excavating solid media, such as soil or solid/bulk waste. It is usually used in conjunction with other technologies, such as treatment or disposal options, to achieve the RAOs for the removed media. The removal response action does not reduce the concentrations of contaminants in the affected media. It merely transfers the contaminants to be dealt with under another response action.

Treatment
Treatment involves destroying contaminants in the affected media; transferring contaminants from one media to another; or altering the contaminants, thus making them innocuous. The result is a reduction in mobility, toxicity, and/or volume (M/T/V) of the waste. Treatment technologies vary between environmental media and can consist of chemical, physical, thermal, and biological processes. Treatment can occur in place or above ground.

Disposal/Discharge
Disposal involves transferring contaminated media, concentrated contaminants, or other related materials to a site reserved for treatment or long-term storage of such materials. This generally takes place on site in an engineered landfill or off site in an approved commercial or municipal landfill. Disposal does not reduce the concentration or volume of waste. It relocates it to a secure area.

Discharge also involves transferring contaminated media and generally refers to managing liquids. This response action involves discharging site liquids to an off site location, such as a wastewater treatment plant, for disposal or further treatment. It also may involve on site discharge via surface water, injection wells, or infiltration galleries.

4.2 Preliminary Screening of Technologies and Process Options

For each GRA, there are various remediation methods, or technologies, used to carry out the response action. The term technology refers to general categories of technology types, such as in situ treatment. Each technology may have several process options, which refer to the specific material, equipment, or method used to implement a technology. For example, under the technology category of in situ treatment for soil, there would be several process options, including soil vapor extraction (SVE) and solidification/stabilization. These technologies describe broad categories used in remedial action alternatives but do not address details, such as performance data, associated with specific process options.

In this initial phase of technology screening, process options and technology types are eliminated from consideration if they are technically impractical due to a lack of compatibility with site characteristics (e.g., physical features of the site and chemical characteristics of the media of concern), or if the technology has not been proven to effectively address the COCs. These screening criteria are applied based on published information, experience with the technologies and process options, knowledge of site characteristics, and engineering judgment. Specifically, a technology or process option is rejected during the preliminary screening if it:

- Would not be a practical method for the volume or area of contaminated media that is to be remediated.
- Would not be an effective method for cleanup of all the contaminants, either as a sole technology or in combination with another technology, because of characteristics or concentrations of contaminants present at the site.
- Would not be feasible or effective because of site conditions, including conditions such as location and size, surrounding land use, climate, geology and soils, hydrogeology, and characteristics of the contaminated media.
- Could not be effectively administered.
- Has not been successfully demonstrated for the site contaminants or media.

Table 4-1 describes the process options, presents initial screening comments, and summarizes the technology screening process for groundwater at this site. Similarly, **Table 4-2** presents the initial screening of technologies and process options for soil. A brief description of each process option is included in the tables to provide an understanding of each option and to assist in evaluating its technical implementability. The screening comments address the technical feasibility and ability of a given process option to serve its intended purpose. They also include a statement as to whether each process option is retained for further evaluation or rejected. The retained technologies and process options are further evaluated in the next section.

4.3 Evaluation of Retained Technologies and Process Options

Incorporating all process options that survive the preliminary screening into detailed alternatives would result in a cumbersome number of remedial action alternatives. To reduce that number, process options that survive initial screening are reevaluated on the basis of effectiveness, implementability, and cost. In cases where several process options have similar evaluations, a single process option considered representative of each technology type is selected. Identifying a representative process option for each technology type is not intended to limit the process options that could be employed in the remedial design, but instead, provide a basis for evaluating a manageable number of alternatives. In some cases, more than one process option may have been selected for a technology type because the options were sufficiently different in performance to preclude selecting one as representative of all. The criteria used for this evaluation are summarized below.

Effectiveness

Specific technology processes are evaluated for their effectiveness in protecting human health and the environment and in satisfying one or more of the RAOs. This evaluation compares the effectiveness of the process options within the same technology types while maintaining a variety of technologies needed to develop a range of alternatives. This criterion focuses on:

- The degree to which a process option reduces M/T/V through treatment and minimizes residual risks.
- The effectiveness in handling the estimated areas or volume of media and meeting the RAOs identified.
- The effectiveness in protecting human health and the environment during the construction phase and operation, and how quickly it achieves protection.
- The degree to which the process option complies with all requirements.
- How proven and reliable the process option is with respect to the contaminants at the site.

Options providing significantly less effectiveness than other, more promising options are eliminated from further consideration.

Implementability

This criterion focuses on the technical feasibility and availability of the option and the administrative feasibility of implementing the option. During the preliminary screening, process options that were ineffective or unworkable at the site were eliminated as being technically infeasible. This evaluation continues the screening on a more detailed level, placing greater emphasis on the institutional aspects. Implementability considers:

- Availability of treatment, storage, and disposal services as well as capacity.
- Availability of necessary equipment and skilled workers to implement the technology.

Options that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time are eliminated from further consideration.

Cost

The costs of construction and any long-term costs associated with operation and maintenance (O&M) are also considered in this evaluation. Costs that are excessive compared to the overall effectiveness of options are considered as one of several factors used to eliminate options. Options providing effectiveness and implementability similar to those of another option and using a similar method of treatment or engineering control, but at a greater cost, are eliminated from further consideration. It should be noted that the greatest cost variability during site remediation is generally seen between the technology types, rather than within specific process options in a given technology.

Relative costs are used rather than detailed estimates. At this stage in the process, the cost analyses are made on the basis of engineering judgment. Each process option is evaluated as to whether costs are high, moderate, or low relative to other process options of the same technology groups.

The evaluation of the retained technologies and process options for groundwater based on effectiveness, implementability, and cost is presented in **Table 4-3**. The evaluation of technologies and process options for soil is presented in **Table 4-4**. Summaries of the retained technologies and process options for groundwater and soil are presented in **Tables 4-5** and **4-6**, respectively.

Section 5
Development of Remedial Alternatives

The objective of this section is to combine the list of previously screened technologies and process options to form a range of remedial action alternatives for groundwater and soil. The retained technologies and process options presented in Tables 4-5 and 4-6 represent those actions that could be effective as part of remedial alternatives for the media of concern at this site. The following sections present the developed alternatives for this site. In accordance with the RAOs, these alternatives are focused on addressing the areas of concern defined as described in Section 2 for groundwater and soil.

To achieve the goal of developing a range of cleanup options and providing sufficient information to adequately compare alternatives against one another, it is important to consider the nature of the site or media to be addressed. For example, elements of a remedial alternative proposed for soil may be appropriate for one soil area of concern but not for another. For this reason, it is important to consider the characteristics of each of the areas of concern, as described in Section 2, when considering the feasibility of an alternative at a particular area of concern. For example, the main constituents of concern at GW Area #3 are dissolved CEEs while free phase fuel oil is the main constituent of concern at GW Area #4. This means that technologies that may be feasible in GW Area #3 might not be feasible in GW Area #4.

The range of alternatives developed for groundwater includes no action, institutional controls and long-term monitoring, hydraulic containment (regolith and/or bedrock zones), in situ chemical oxidation, dual-phase extraction, in situ air sparging, permeable reactive barrier walls, and in situ thermal treatment. For soil, the range of alternatives includes no action, institutional controls, soil excavation and offsite disposal, soil excavation and onsite ex situ treatment, source containment, in situ soil vapor extraction (SVE), deep soil mixing with oxidant, and in situ thermal treatment. In formulating alternatives, contaminants with concentrations above RGs (as discussed in Section 3.2.2), applicable technologies, and the contaminants that these technologies most effectively addressed were considered.

Each alternative developed and described in this section was evaluated to determine its overall effectiveness, implementability, and cost. These criteria for alternative evaluation are similar to those previously used to evaluate the process options (Section 4.3).With the exception of the no action, institutional controls, and source containment alternatives, each alternative presented in this section includes some form of active remediation. Monitored natural attenuation (MNA) is not discussed extensively in this section but may be appropriate as a component of the long-term remedy for this site. MNA can be successful once active remediation has reached a certain endpoint, the effectiveness of further active remediation will be limited, and risks to receptors are negligible. However, use of MNA does not preclude satisfying the RAOs and RGs established for this site.

After evaluating each criterion for each alternative, the remedial action alternatives described in this section undergo a more detailed analysis, which is documented in Section 6. A summary of the developed alternatives for this site is presented in **Tables 5-1** and **5-2** for groundwater and soil, respectively. The groundwater alternatives are described in Section 5.1 below followed by the descriptions of the soil alternatives in Section 5.2. Section 5.3 presents combination remedial alternatives that use technologies potentially capable of addressing both soil and groundwater. Additional details regarding the assumptions for each alternative are also available in the detailed cost estimates presented in **Appendix A**.

5. 1 Groundwater Alternatives

5.1.1 Alternative 1 - No Action

Description

Under this alternative, no action would be taken to remediate any affected media at the site. Reassessments of conditions would occur at 5-year intervals in accordance with CERCLA.

Effectiveness

The no action alternative is required by the NCP to be carried through the screening process, as it serves as a baseline for comparison of the site remedial action alternatives. This alternative will not reduce the potential exposure of receptors to site contaminants. This alternative is also not effective in reducing the mobility, toxicity, and volume (M/T/V) of contaminants beyond any reduction already occurring naturally at the site.

Implementability

There are no tasks under this alternative that require implementation except for the 5-year assessments. Personnel are readily available and procedures are in place to easily complete these assessments.

Cost

Very low costs are associated with this alternative relative to other remedial action alternatives. No capital or O&M costs are associated with this alternative other than those required for the periodic assessments.

5.1.2 Alternative 2 - Institutional Controls & Long-Term Monitoring

Description

This alternative includes the following components:

- Implementing deed restrictions that prevent prolonged exposure to contaminants, control future development, prevent installation of new potable wells, and prevent potable use of groundwater and surface water within the affected area.

- Implementing a monitoring plan for groundwater and surface water sitewide to evaluate COC concentrations in these media on a routine basis. This monitoring plan includes 30 years of implementation and conducting reassessments of the conditions at the site every five years.

Effectiveness

This alternative would result in minimizing the exposure of human receptors to contaminants. The alternative would not further reduce the M/T/V of contaminants, but it would reduce or eliminate many estimated risks by eliminating complete exposure pathways. Monitoring proposed under this alternative would allow SCDHEC to assess the ongoing threats to human health and the environment posed by the affected media at the site.

Implementability

Implementation of this alternative is considered technically feasible since equipment and materials are readily available and procedures are in place.

Cost

Low costs are associated with this alternative relative to other remedial action alternatives. Expenditures include capital costs for deed restrictions, and O&M costs include groundwater and surface water monitoring.

5.1.3 Alternative 3 – Hydraulic Containment and Onsite Physical/Chemical Treatment

Description

This alternative would consist of collecting groundwater through extraction wells and trenches, and pumping the impacted water to an onsite wastewater treatment system with subsequent discharge to the municipal publicly owned treatment works (POTW) through an existing industrial discharge permit. The institutional controls described in Section 5.1.2 would also be established. While not a component of the alternative assumptions for this FS, this alternative could also include groundwater polishing in the regolith (shallow) hydraulic zone using phytoremediation. If incorporated into the selected remedial alternative, the viability of polishing using phytoremediation would need to be evaluated through additional investigation and groundwater modeling.

Under this alternative and as described in this FS, containment would be set up in both regolith and bedrock hydraulic zones. Extracted groundwater from both zones would be transferred to the existing groundwater treatment system. It is assumed that six additional extraction wells would be installed in the regolith to the top of bedrock and six other extraction wells would be installed into bedrock. Planned locations for the regolith and bedrock zones are shown on **Figures 5-1** and **5-2**, respectively. These locations were developed based on engineering judgment and data collected during the RI. If this alternative is selected, a more detailed analysis involving groundwater modeling would be necessary to support decisions regarding hydraulic containment system design.

As seen in Figure 5-1, the six regolith extraction wells would be located so that they form a hydraulic barrier with the existing interceptor trench. Based on existing extraction well production and the estimated surface water infiltration at the site, extraction rates between 3 and 5 gpm are assumed for each regolith well.

Bedrock extraction wells would be installed to contain contaminated groundwater vertically towards deeper portions of the aquifer and laterally across Wildcat Creek. The bedrock containment system would address the plume areas with the highest groundwater COC concentrations, as shown in Figure 5-2. The estimated groundwater extraction rate for each bedrock well is between 3 and 5 gpm.

Effectiveness

This alternative would be effective in reducing the M/T/V of contaminants in groundwater and may therefore meet some of the established RAOs for the site. This alternative would be expected to minimize the mobility but not the toxicity or volume of contaminants in groundwater. Monitoring proposed under this alternative would allow SCDHEC to assess the ongoing threats to human health and the environment posed by the affected media at the site.

Two extraction wells and one extraction trench are currently in operation. Although the operation of the existing extraction system can be improved, previous operation has shown that extraction can be used as an effective treatment and containment method in the fuel oil GW Area #4.

Bedrock containment would minimize the mobility of groundwater but do little to minimize the toxicity or volume of contaminants. However, groundwater containment in bedrock may be effective when combined with source treatment, such as in situ chemical oxidation, in the regolith zone. No sources are suspected to be in the bedrock, and therefore removing contaminants from the regolith zone will significantly reduce the mass of contaminants flowing into the bedrock zone.

As discussed in Section 2, groundwater flow rates in the regolith are not expected to be greater than 26 gpm sitewide. Although this will not affect effectiveness with containment, it will significantly decrease the volume of contaminants that can be treated.

Additionally, a higher permeability alluvium area is located next to Wildcat Creek just downgradient of the plume edge. If extraction wells are located too close to this high permeability area, water from the creek may keep the water table from decreasing significantly during extraction and thus immobilizing the contaminated groundwater in the lower permeability regolith hydraulic zone. The additional extraction wells in the regolith zone would be located further upgradient from the alluvium so that minimal creek water is drawn up through the extraction wells.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. Equipment, services, and personnel should be readily available from many vendors. Upgrades to increase the capacity of the existing groundwater treatment system would likely be required.

Cost

Since a groundwater treatment system is already operational, capital costs are significantly reduced for this alternative. Capital costs for this alternative include installing extraction wells and expanding the current extraction and treatment system. Low costs are associated with this alternative relative to other remedial action alternatives. O&M costs, including routine extraction and treatment system monitoring and maintenance are moderate and will be relatively constant over the potential lifetime of the treatment plant.

5.1.4 Alternative 4 – In Situ Chemical Oxidation, Dual-Phase Extraction, and Bedrock Extraction

Description

This alternative includes several process options. In situ chemical oxidation will be performed to treat dissolved-phase contaminants in the regolith zone. Dual phase extraction (DPE) will be used to treat free product fuel oil in GW Area #4. Finally, bedrock contaminants will be contained and treated using extraction wells as described above in Section 5.1.3. The institutional controls described in Section 5.1.2 would also be established.

In Situ Chemical Oxidation

Under this alternative, an oxidizing agent would be injected into the groundwater plumes in the regolith hydraulic zone to destroy organic contaminants. The in situ chemical oxidation alternative relies on injection of a powerful oxidizing agent to destroy the organic contaminants. Because sodium persulfate is known to effectively oxidize all three COC types (CEE, CB, and BTEX), this oxidizer is used in the FS analysis. Often ferrous iron is used to activate the sodium persulfate to produce the sulfate free radical that acts as the powerful oxidizing agent.

For costing and evaluation purposes, it was assumed that chemical oxidation would be applied across all of the contaminated areas on site in two rounds. During the design phase, bench- and pilot-scale treatability testing would be conducted to evaluate various process options.

Typical radii of influence for injections range from 2.5 feet for tight clay to 25 feet in permeable saturated soils (ITRC, 2005). A radius of influence of 15 feet was assumed for the purposes of this FS based on the silt to sandy silt conditions observed at the site. It was also assumed that two wells, each with 20 feet of screen, would be installed at each injection location to allow effective vertical distribution of the oxidizing agent. Using these assumptions, approximately 1,000 regolith injection points (500 locations with two wells per location) would be required to disperse the chemical oxidants throughout the groundwater plumes at the site in the area shown in Figure 5-1.

During the design phase, the radius of influence developed from pilot-scale testing would be used to determine the actual number of injection points required. Injection points would be installed vertically to provide efficient dispersal of reagents over the entire depth of contamination, which varies across the site. Injectors are designed to withstand the elevated temperatures and pressures associated with the chemical oxidation process. If this alternative is selected, the details of the in-situ oxidation treatment program would be further developed based on the results of pilot-scale testing.

Treatment verification monitoring would include collection of groundwater samples from existing monitoring wells within and downgradient of the treatment areas. Samples would be analyzed for VOCs and metals. Metals analysis would be performed to determine if metals present in the aquifer were mobilized by the oxidizing agents. Several post-treatment monitoring events would be performed to ensure no contaminant rebound occurs. Results from the monitoring program would determine whether or not additional rounds of reagent application are required to meet the treatment objectives. For purposes of this FS, two additional injection rounds are assumed.

Following the final injection, MNA may be warranted to assess further attenuation from areas that did not reach RGs and to ensure that COC concentrations in all treated areas remain below regulatory criteria. SCDHEC allows a 3-year MNA evaluation period. If MNA is not demonstrated as effective in this period, more active remediation may be warranted. For the purposes of this FS, MNA and associated monitoring are assumed to last for 10 years in regolith groundwater.

Dual-Phase Extraction

In-situ chemical oxidation is effective for remediating low concentration organic groundwater plumes. However, the amount of oxidizing agents needed to meet the stoichiometric ratios for effectively treating source areas is extremely high. Thus, chemical oxidation is not likely to be used to treat free product in the fuel oil GW Area #4. DPE will be performed in this area to remove the free product.

DPE is a technology that uses a high vacuum system to remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface. The vacuum will lower the water table around the well to expose more of the surrounding formation. Contaminants above the water table are then removed via vacuum extraction. Extracted groundwater and fuel oil will be treated above ground using the existing oil/water separator and carbon adsorption unit.

Bedrock Extraction

Because of the uncertainty of injection into bedrock zones, in situ chemical oxidation was not chosen as a process option for bedrock contamination. Bedrock COCs will be contained by installing extraction wells as described in Section 5.1.3 at the locations shown in Figure 5-2.

Since the bedrock extraction wells will be installed in locations with the highest observed VOC concentrations, the extraction wells will also serve to reduce VOC mass in the site interior. Long-term monitoring would be continued in bedrock for an assumed period of 30 years. However, treating high concentration areas in the regolith zone using chemical oxidation and DPE may cause bedrock concentrations to decrease below RGs. In that case, the extraction system and monitoring may be stopped prior to 30 years.

Effectiveness

This alternative would be effective in reducing the M/T/V of contaminants in the regolith and bedrock, and may therefore meet the established RAOs for the site. This alternative would be expected to reduce toxicity and volume of contaminants in the regolith zone through treatment and limit the mobility of groundwater in bedrock through containment. Groundwater containment in bedrock can be effective when combined with in situ chemical oxidation in the above regolith zone. No sources are suspected in the bedrock, and therefore, removing contaminants from the regolith zone will significantly reduce the mass of contaminants flowing into the bedrock zone. Monitoring proposed under this alternative would allow SCDHEC to assess the ongoing threats to human health and the environment posed by the affected media at the site.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. Equipment, services, and personnel should be readily available from many vendors for all process options.

Cost

High costs are associated with this alternative relative to other remedial action alternatives due to the size of the treatment area. Expenditures include capital costs for equipment and construction of injection wells, injection material, the DPE system, and the bedrock containment system. Some O&M costs also exist and include long-term monitoring of the groundwater and long-term O&M of the bedrock containment system.

5.1.5 Alternative 5 – Air Sparging, Dual-Phase Extraction, and Bedrock Extraction

Description

This alternative involves an air sparging system in regolith groundwater to treat the majority of the plume area. As with Alternative 4, this treatment process would be combined with DPE in the fuel oil GW Area #4 to treat free product, which would be completed prior to starting the air sparging system in this area. More details on the DPE system are provided in Section 5.1.4. Additionally, bedrock contaminants will be contained and treated using extraction wells as described above in Section 5.1.3. The institutional controls described in Section 5.1.2 would also be established.

Air Sparging

Air sparging is an in situ treatment technology that uses injected air to remove volatile contaminants from groundwater. As the injected air rises through the groundwater plume, contaminants are stripped from the water and carried towards the surface and removed from the vadose zone through an SVE system. This process is very well known and can remove most types of dissolved-phase VOCs.

For evaluation and cost estimating purposes, CDM assumes that air sparging wells would be installed at the top of bedrock so that air would be allowed to rise through the entire saturated regolith zone. The treatment area for air sparging is the same as in situ chemical oxidation under Alternative 4 and is shown in Figure 5-1. Air sparging wells would be spaced approximately 30 feet from each other (15-foot radii). SVE wells would be installed at one SVE well per four air sparging wells to remove the contaminants as they are volatilized through the vadose zone. SVE wells would be installed above the water table. To allow ambient groundwater flow to redistribute VOCs within the treatment area during air sparging, air would be pulsed into the wells as opposed to a continuous air flow.

Following air sparging, MNA may be warranted to assess further attenuation from areas that did not reach RGs and to ensure that COC concentrations in all treated areas remain below regulatory criteria. SCDHEC allows a 3-year MNA evaluation period. If MNA is not demonstrated as effective in this period, more active remediation may be warranted. For the purposes of this FS, MNA and associated monitoring are assumed to last for 10 years in regolith groundwater.

Bedrock Extraction

Because of the uncertainty of air sparging in bedrock zones, bedrock COCs will be contained by installing extraction wells as described in Section 5.1.3 at the locations shown in Figure 5-2.

Since the bedrock extraction wells will be installed in locations with the highest observed VOC concentrations, the extraction wells will also serve to reduce VOC mass in the site interior. Long-term monitoring would be continued in bedrock for an assumed period of 30 years. However, treating high concentration areas in the regolith zone using air sparging and DPE may cause bedrock concentrations to decrease below RGs. In that case, the extraction system and monitoring may be stopped prior to 30 years.

Effectiveness

This alternative would be effective in reducing the M/T/V of contaminants in the regolith and bedrock, and may therefore meet the established RAOs for the site. This alternative would be expected to reduce the toxicity and volume of contaminants in the regolith zone through treatment and limit the mobility of groundwater in bedrock through containment. Groundwater containment in bedrock can be effective when combined with in situ air sparging in the above regolith zone. No sources are suspected in the bedrock, and therefore, removing contaminants from the regolith zone will significantly reduce the mass of contaminants flowing into the bedrock zone. Monitoring proposed under this alternative would allow SCDHEC to assess the ongoing threats to human health and the environment posed by the affected media at the site.

Implementability

Implementation of this alternative is considered technically feasible. Construction of air sparging, DPE, and bedrock extraction systems could be accomplished through conventional methods, and equipment, services, and personnel should be readily available from many vendors.

Cost

Moderate costs are associated with this alternative relative to other remedial action alternatives. Expenditures include capital costs for equipment and construction of air sparging and SVE wells, the air sparging system, DPE wells, the DPE system, and the bedrock containment system. O&M costs also exist and include long-term groundwater and surface water monitoring and long-term O&M of the bedrock containment system. Significant cost savings would be realized by combining this alternative with Soil Alternative 6 (SVE).

5.1.6 Alternative 6 – Permeable Reactive Barrier Wall, Dual-Phase Extraction, and Bedrock Extraction

Description

This alternative involves constructing a subsurface permeable reactive barrier (PRB) wall to treat affected groundwater before it continues off site. The institutional controls described in Section 5.1.2 would also be established. Treatment walls involve constructing permanent, semi-permanent, or replaceable units across the flow path of a contaminant plume. As groundwater flows though the treatment wall, contaminants are removed by physical, chemical, and/or biological processes.

Although several reactive barrier wall options are available, for purposes of this FS, it is assumed that the barrier wall would be a funnel-and-gate reactive wall with impermeable sections of the wall being used as a funnel to direct groundwater into the permeable gate sections of the wall. The permeable reactive section would consist of granular zero-valent iron and pea gravel. The reactive wall would be constructed by excavating a trench to approximately 60 feet below land surface perpendicular to regolith groundwater flow, as shown in Figure 5-1. Because BTEX compounds will not react through the PRB, biosparge wells would be installed immediately downgradient of the PRB and construction would be the same as for the air sparging wells described in Section 5.1.5. The biosparge wells would not require an SVE system because the BTEX compounds would be aerobically degraded in the subsurface.

The thickness of the permeable reactive wall would be selected based on the required transmissivity of the wall and the required depth of the wall. In addition, the size of excavating equipment necessary to reach the design depth of the wall may control the width of the trench, resulting in a finished wall that is thicker than required. It is anticipated that additional investigation and testing would be required as part of the remedial design phase to define wall alignment and depth. Monitoring wells would also be constructed in the reactive media during construction of the walls.

The backfill for the wall in the funnel areas would consist of naturally deposited inorganic soils excavated from the slurry trench mixed with the water-clay slurry used to maintain the stability of the trench. Geochemical testing would be required to ensure that the clay additive used in the slurry mixture is compatible with the site chemistry. In addition, offsite clean fine-grained soils may be needed to supplement soils excavated from the trench if the excavated soils do not contain a sufficient amount of fine material (i.e., silt and clay). The backfill design should include a geochemical study consisting of backfill design mix testing and long-term chemical compatibility testing. Hydraulic controls are not expected to be necessary because groundwater would be allowed to pass through the iron barriers.

PRB systems are not designed to treat free product areas. Thus, the PRB is not likely to be used in the fuel oil GW Area #4 where free product is present. DPE, as described above, will be performed in this area prior to installing the PRB to remove any free product from the subsurface. The biosparging wells would be installed downgradient of the funnel-and-gate portions of the wall to remove any residual BTEX compounds in the groundwater not destroyed by the wall.

Bedrock groundwater is not addressed with the PRB and dual-phase treatment. The bedrock containment system described above in Section 5.1.3 would be used in this alternative for the bedrock groundwater remedy. Long-term monitoring would be continued in bedrock for an assumed long-term monitoring period of 30 years.

Effectiveness

This alternative would be effective in reducing the exposure of certain receptors to contaminants and may therefore meet some of the established RAOs for the site. This alternative would be expected to reduce the toxicity and volume of contaminants in regolith groundwater through treatment prior to moving off site. However, it would not reduce M/T/V in onsite source areas. Bedrock containment would minimize the mobility of groundwater but do little to minimize the toxicity or volume of contaminants. Monitoring proposed under this alternative would allow SCDHEC to assess the ongoing threats to human health and the environment posed by the affected media at the site.

Implementability

Implementation of this alternative is considered technically feasible. However, while vendors have reported that conventional construction methods can be used up to 80 feet, constructing a 60-foot deep wall involves a higher level of difficulty than most of the other remedial alternatives. The number of vendors that can successfully install such a wall may be limited. Construction in the alluvial areas may also be difficult because of the identified presence of very large boulders in the subsurface at depths of approximately 40 feet below the surface.

Cost

Moderate costs are associated with this alternative relative to other remedial action alternatives. Expenditures include capital costs for equipment and construction of a PRB wall, the DPE system, and the bedrock containment system. O&M costs also exist and include long-term monitoring of the PRB wall, some O&M for the PRB wall, and long-term O&M of the bedrock containment system.

5.2 Soil Alternatives

5.2.1 Alternative 1 - No Action

Description

Under this alternative, no action would be taken to remediate any affected media at the site. Reassessments of conditions would occur at 5-year intervals in accordance with CERCLA.

Effectiveness

The no action alternative is required by the NCP to be carried through the screening process, as it serves as a baseline for comparison of the site remedial action alternatives. This alternative will not reduce the exposure of receptors to site contaminants. This alternative is also not effective in reducing M/T/V of contaminants beyond any reduction already occurring naturally at the site.

Implementability

There are no tasks under this alternative that require implementation except for the 5-year assessments. Personnel are readily available and procedures are in place to easily complete these assessments.

Cost

Very low costs are associated with this alternative relative to other remedial action alternatives. No capital or O&M costs are associated with this alternative other than those required for the periodic assessments.

5.2.2 Alternative 2 – Institutional Controls

Description

This alternative includes the following components:

- Implementing deed restrictions that prevent prolonged exposure to contaminants, control future development, prevent installation of new potable wells, and prevent potable use of groundwater within the affected area.

- Constructing fencing around the soil areas of concern as an additional institutional control to prevent access to potentially hazardous areas.

- Conducting reassessments of the conditions at the site every five years.

Long term monitoring is only anticipated for groundwater and surface water, and they are covered in the groundwater portion of this section (Section 5.1).

Effectiveness

This alternative would result in minimizing the exposure of human and ecological receptors to contaminants. The alternative would not further reduce the M/T/V of contaminants, but it would reduce or eliminate many estimated risks by eliminating complete exposure pathways. Monitoring proposed under this alternative would allow SCDHEC to assess the ongoing threats to human health and the environment posed by the affected media at the site.

Implementability

Implementation of this alternative is considered technically feasible since equipment and materials are readily available and procedures are in place.

Cost

Low costs are associated with this alternative relative to other remedial action alternatives. Expenditures include capital costs for fencing and deed restrictions. O&M costs also exist and include media monitoring, periodic mowing, and maintenance of fencing.

5.2.3 Alternative 3 – Soil Excavation and Offsite Disposal

Description

This alternative consists of excavating impacted material and then transporting this material off site to an appropriate regulated landfill. Soil would be excavated and then loaded onto trucks. The excavated material would then be landfilled in a regulated solid waste landfill, or if the waste is determined to be a hazardous, disposed of in a hazardous waste landfill.

The soil volumes to be excavated were estimated as detailed in the *Feasibility Study Alternatives Analysis - Soil Volumes* memo sent to SCDHEC in September 2008 (CDM, 2008). To estimate the VOC impacted soil volumes, CDM identified all RI soil sampling locations and corresponding depths that exhibited concentrations exceeding the covered and uncovered SSLs. Sample locations that only had SSL exceedances in soil below the water table were not considered as impacted soil areas.

As shown in **Figure 5-3**, the areal extent of VOC exceedances was grouped into six locations (areas). Since covered and uncovered SSLs were applied to this estimation, the location areas for volume estimation differed from the soil areas of concern identified during the RI (Figure 2-3). The impacted depth or depth to water (if impacts extended to water table) varied between 18 and 21 feet for the six locations. Based on the impacted areas and depths, the total soil volume to be remediated was estimated to be approximately 200,000 square feet and 148,000 cubic yards.

Based on the soil excavation areas developed above, this alternative includes the following components:

- Remove existing building structures in soil areas of concern.
- Excavate defined impacted VOC soil locations (Figure 5-3) to impacted depth above the water table.
- Excavate 1-foot layer of soil in locations where metals exceed PRGs. PRGs were used instead of SSLs because no groundwater metal impacts are observed at this site. Ten sample locations had metals exceedances in areas outside of the VOC exceedance areas. A 10-foot by 10-foot (by 1 foot deep) layer would be excavated from each metals exceedance location.
- Dispose of excavated materials off site at an appropriate regulated landfill.
- Backfill excavated areas with clean soil, and in areas where building slabs were removed, finish with a cover consistent with the 103.3 DAF described in Section 2.
- Institutional controls as specified in Section 5.2.2.

Effectiveness

Removal of contaminated soil would reduce the risks associated with contaminants in soil at the site. Contaminant toxicity and volume would be reduced, and the migration of contaminants to groundwater would also be minimized.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. Equipment, services, and personnel should be readily available from many vendors.

Cost

The costs associated with this alternative are volume, transportation, and treatment dependent. These costs are expected to be high compared with other remedial action alternatives based on anticipated volumes. Expenditures include capital costs for equipment, demolition, excavation, and disposal.

5.2.4 Alternative 4 – Source Containment

Description

This alternative includes installing a cap over the soil areas of concern, as shown in Figure 5-3. The cap would be either a hydraulic barrier such as clay and/or a physical barrier such as a membrane liner. This alternative includes the following components:

- Demolishing existing building structures in covered areas.
- Excavating a 1-foot layer of soil in locations where metals exceed PRGs. Ten sample locations had metals exceedances in areas outside of the VOC exceedance areas. A 10-foot by 10-foot (by 1 foot) layer would be excavated from each metals exceedance location. The estimated surface area and volume of metals soil locations to be excavated is therefore 10 cubic yards.
- Relocating excavated soils for metals exceedances to defined VOC location areas for capping.
- Capping the soil areas of concern. The estimated combined surface area of the affected soil areas is approximately 300,000 square feet or 7 acres.
- Constructing surface water run on controls to capture water and direct it around the perimeter of the cap.
- Implementing institutional controls as specified in Section 5.2.2.

For this alternative, it is assumed that the barrier layer of the cap for the defined area will be designed to provide a permeability of less than 1×10^{-5} cm/s in accordance with the South Carolina closure requirements for municipal solid waste landfills (61-107.258). The cap will include, at a minimum, 18 inches of earthen material as an infiltration layer and 6 inches of earthen material as an erosion layer for plant growth. This alternative includes grading the topsoil and common fill layers of the cap to promote surface drainage away from the affected soil areas and reduce infiltration.

Effectiveness

Although they do not treat or destroy contaminants, the caps proposed under this alternative would minimize the amount of water passing through the affected soil areas (both vertical and horizontal) and thus minimize the release of contaminants from the affected soil areas. The soil cap would also provide an additional barrier (beyond fencing) that prevents direct exposure to affected soils. This alternative is expected to reduce or eliminate contaminant migration from the affected soil areas and eventually result in reduction of contaminant concentrations in other media as well. Long-term monitoring would be required to assess any potential impacts of this alternative.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. Equipment, services, and personnel should be readily available from many vendors. A routine inspection and maintenance program would be necessary to maintain the integrity of the cap.

Cost

Low costs are associated with this alternative relative to other remedial action alternatives. Expenditures include capital costs for surface water run on controls, equipment, and construction of the cap. O&M costs also exist and include such items as monitoring and maintenance the drainage controls and the cap.

5.2.5 Alternative 5 – Soil Excavation and Onsite Ex Situ Treatment

Description

This alternative is similar to Alternative 3 except that excavated materials would be treated on site and returned to the excavation locations as fill material. Soil from the soil areas of concern shown in Figure 5-3 would be excavated and then transported to a central area on site for staging and treatment. Excavation would include removal of soil to the impacted depth above the water table. Excavation volumes estimated for FS purposes were detailed in Section 5.2.3. The excavated material would then be treated and returned to its original location as fill material.

Excavated soil would be treated using a process option to be determined following treatability studies during remedial design. Process options include biological methods (biopiles or landfarming) or chemical treatment. Preliminary cost estimates for incineration and thermal desorption indicated very high costs compared with other process options, and they were not considered further.

Preprocessing requirements may include solids separation, sizing, and dewatering. Techniques could include screens, shredders, and grinders. These processes would remove any material larger than two inches in diameter so that it could be appropriately dealt with; create a more uniform mixture that can be treated more efficiently; and prevent large-diameter material from damaging any components of the treatment system. Following treatment, the soil will be replaced into the excavation holes as backfill material and then compacted.

This remedial alternative also includes additional institutional controls consisting of fugitive dust controls during excavation, transport, handling, and replacement; covering stockpiles with tarps or plastic sheeting; and surface water runoff controls. These control methods would be monitored to ensure that the RAOs were being met and to assess the effectiveness of the remedial action.

Effectiveness

Removal of affected soil material with onsite treatment would reduce the risks associated with contaminated soils at the site. Contaminant toxicity and volume would be reduced, and the migration of contaminants to groundwater would also be minimized. Treatability studies would be required to evaluate the effectiveness of the proposed process options(s) in sufficiently reducing levels of all COCs present in the affected soils.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. Treatability studies of the treatment technologies would need to be performed. Equipment, services, and personnel should be readily available from many vendors. Large areas are available on site for staging excavated soils. Depending on the final treatment process option used, treatment of the affected soils may increase the volume of the excavated soil. Some offsite disposal may be required.

Cost

The costs associated with this alternative are volume and treatment dependent. These costs are expected to be moderate to high compared with other remedial action alternatives based on anticipated volumes. Expenditures include capital costs for equipment, excavation, building demolition, treatability studies, treatment materials, and backfilling and re-grading.

5.2.6 Alternative 6 – Soil Vapor Extraction

Description

This alternative involves the in situ treatment of affected soils in the area shown in Figure 5-3. The final treatment process selected would depend upon the outcome of treatability testing and would be determined during remedial design. Organic contaminants within the affected soil would be collected by SVE or, as a contingency, thermally enhanced SVE. This alternative also includes institutional controls and select metals excavation, as previously described under Soil Alternatives 3 and 4.

An in situ SVE treatment system can be developed by installing a series of wells above the water table and applying a vacuum to the unsaturated soil. The soil vapor recovered by the wells is then treated ex situ. Impermeable (geomembrane) covers are often placed on top of the soil to increase the radius of influence of the SVE wells and reduce short-circuiting of air in the subsurface. This analysis assumes that the SVE wells will have a 20-foot radius of influence, and each well will be operated at a vapor flow rate of 20 cubic feet per minute. Approximately 600 SVE wells will be required.

Thermal enhancements include installing a series of electrodes to the subsurface above the water table. The electrodes heat the soil by electrical resistance, which increases the vadose zone permeability by reducing moisture and mobilizes VOCs from soil. Thermal enhancement can be applied as a contingency should the vapor extraction rates be limited by the formation and SVE operation prolonged. As SVE removes the vapors, water condensed from the vapor stream and the extracted vapors require ex situ treatment.

Effectiveness

In situ treatment of the soil areas of concern would reduce the risks associated with contaminated soils at the site. Contaminant toxicity and volume would be decreased, and the migration of contaminants to groundwater would also be minimized. Treatability studies would be required to evaluate the effectiveness of the proposed process options(s) in sufficiently reducing levels of all COCs present in the affected soils.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. Equipment, services, and personnel should be readily available from many vendors.

Cost

Capital costs for SVE alone are low to moderate compared to other remedial alternatives. Capital costs for thermal desorption are very high because of the power requirements of this option and the extent of the thermal treatment area. O&M costs are low for both options.

5.3 Combination Groundwater and Soil Alternatives

This section presents combination alternatives for both soil and groundwater. Whereas the alternatives presented in the previous two subsections (5.1 and 5.2) were focused on applying technologies across all areas of concern, the alternatives in this section are more focused on applying different technologies to different areas and applying technologies that treat groundwater and soil simultaneously.

5.3.1 Alternative 1 – Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced Multi-Phase Extraction, and Deep Soil Mixing

Description

This alternative involves hydraulic containment for groundwater and soil remediation consisting of hot spot removal, SVE in the Burn Pit Area, thermal-enhanced multi-phase extraction (MPE) in the Fuel Oil Area, and deep soil mixing with an oxidant. Specifically, this alternative includes the following components:

- Institutional controls as described in Section 5.2.2.
- Excavation and offsite disposal of VOC Principal Threat Source Material (PTSM). For the purposes of this FS, PTSM is defined as soil with any VOC whose concentration exceeds 20 times EPA Toxicity Characteristic Leaching Procedure (TCLP) criteria, as defined in 40 CFR Part 261.24 (i.e., PTSM = soil concentration in mg/kg > 20 X TCLP criteria in mg/L). PTSM shall also include soil with VOC concentrations that pose an incremental cancer risk of 10^{-3} or greater. This is calculated as any VOC whose concentration exceeds 1,000 times the corresponding SSL (covered or uncovered) for that location. This component is described further below.
- Excavation and offsite disposal of metals in soil exceeding RGs outside of VOC treatment areas, as described in Section 5.2.3.
- SVE in the Burn Pit Area. This component is described further below.
- MPE with thermal enhancements in the Fuel Oil Area. This component is described further below.
- Deep soil mixing with oxidant in VOC impacted areas in soil and regolith groundwater outside of the Burn Pit and Fuel Oil areas. This component is described further below.
- Hydraulic containment with onsite physical/chemical treatment for both the regolith and bedrock hydraulic zones, as described in Section 5.1.3.
- Groundwater and surface water monitoring, as described in Section 5.1.2.

Figure 5-4 outlines the treatment areas for this alternative and the associated technologies. Excavation of PTSM soil will be performed in two areas (RISB-25 and RISB-64). The location of RISB-25 can be excavated by conventional means. RISB-64 is located beneath a building and will require concrete removal and shoring of the excavation walls. The excavated soil disposal will be at an offsite permitted facility.

The soil surrounding the PTSM locations and other soil exceeding the RGs for VOCs will be addressed using deep soil mixing with an oxidant to destruct the VOCs. In areas where the soil exceedances overlie regolith groundwater having VOC concentrations in groundwater in excess of approximately 1,000 ug/L, the soil mixing depth will be extended through the vadose zone to the depth of refusal, estimated to range from 15 to 30 feet. In other areas with RG exceedances, identified by the shallow zones areas on Figure 5-4, soil mixing will extend to the depth of the water table, approximately 17 to 18 feet.

The oxidant selected for this analysis is potassium permanganate, which is assumed to be applied in dry or slurry form at an application rate of approximately one pound of potassium permanganate per cubic foot of soil or one percent. The soil mixing is assumed to use mixing columns consisting of a system of overlapping augers or blade mixers.

This alternative also includes applying SVE to the Burn Pit Area soil in the manner described earlier in Section 5.2.6. However, because of the limited amount of soil data currently available in the Burn Pit Area, additional assessment should be performed to confirm the need for SVE in this area. A pilot test should also be performed prior to final design should the additional assessment conclude that remediation in this area is required. For the purposes of this FS, CDM assumes that a soil cover will be required along with 30 SVE wells and the associated vapor recovery and treatment equipment.

The Fuel Oil Area under this alternative will be remediated using thermal-enhanced MPE. The thermal enhancements will be applied using electrical resistance heating (ERH) to volatize and mobilize the fuel oil for recovery as vapors using SVE and as free product liquid using total fluids extraction. MPE wells will be collocated with the ERH electrodes. Vapors and total fluids will be collected from the MPE wells. The treatment train for this process will include condensate collection from the vapor, vapor treatment by thermal oxidation, disposal of fuel oil, and water treatment.

Thermal treatment using ERH will permanently destroy wells and other equipment located within the treatment area. As such, operation of the existing groundwater extraction and treatment system would cease during thermal treatment. For costing purposes, a new hydraulic containment system would be required under this alternative as outlined in Section 5.1.3. If this combination alternative is selected, a more detailed analysis, potentially involving pre-design investigation and groundwater modeling, would be necessary to support decisions regarding hydraulic containment system design.

Following certain components of this remedial alternative, MNA may be warranted to assess further attenuation from areas that did not reach RGs and to ensure that COC concentrations in all treated areas remain below regulatory criteria. SCDHEC allows a 3-year MNA evaluation period. If MNA is not demonstrated as effective in this period, more active remediation may be warranted. For the purposes of this FS, MNA and associated monitoring are assumed to last for 10 years in regolith groundwater.

Effectiveness

This alternative is expected to be protective of human health and the environment and meet the established RAOs. The M/T/V of contaminants in soil would be reduced significantly through select excavation and offsite disposal and deep soil mixing. Treatability studies would be required to evaluate the effectiveness of SVE and deep soil mixing in sufficiently reducing levels of all COCs present in the affected soils.

The M/T/V of contaminants in groundwater would also be reduced through deep soil mixing in strategic areas. However, hydraulic containment would have limited effects on the toxicity and volume of contaminants in groundwater. The proposed groundwater measures are unlikely to initially reduce groundwater concentrations below RGs although a significant contaminant mass in groundwater would be effectively treated. Monitoring of natural attenuation following this treatment would likely be required for several years. A 30-year monitoring period is assumed for the alternative evaluation.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through a combination of conventional and specialized construction methods. Equipment, services, and personnel should be readily available from select vendors. Upgrades to increase the capacity of the existing groundwater treatment system would likely be required, and the potential effects of the oxidant used in the deep soil mixing on the water treatment system requirements may add additional cost to this alternative.

Cost

The costs for this alternative are the highest of the combination alternatives. Capital costs for this alternative include extraction well installation, treatment system expansion, institutional controls, excavation, building demolition, SVE well and system installation, thermal treatment, MPE wells, and deep soil mixing. O&M costs also exist and include media monitoring, SVE system O&M, treatment system O&M, and MPE system O&M.

5.3.2 Alternative 2 – Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Air Sparging

Description

This alternative involves hydraulic containment, thermal-enhanced MPE, and air sparging for groundwater and soil remediation consisting of hot spot removal and SVE. Specifically, this alternative includes the following components:

- Institutional controls as described in Section 5.2.2.
- Excavation and offsite disposal of VOC PTSM, as defined above in Section 5.3.1.
- Excavation and offsite disposal of metals exceeding RGs outside of VOC treatment areas, as described in Section 5.2.3.
- SVE for VOC impacted areas above the water table, as described in Section 5.2.6. SVE will be combined with air sparging.
- Hydraulic containment with onsite physical/chemical treatment for the bedrock hydraulic zone, as described in Section 5.1.3.
- Thermal-enhanced MPE for the Fuel Oil Area, as described in Section 5.3.1.
- Air sparing for VOC impacted areas in regolith groundwater, as described in Section 5.1.5. Air sparging will follow excavation of PTSM.
- Groundwater and surface water monitoring, as described in Section 5.1.2.

Figure 5-5 outlines the treatment areas for this alternative and the associated technologies. Following certain components of this remedial alternative, MNA may be warranted to assess further attenuation from areas that did not reach RGs and to ensure that COC concentrations in all treated areas remain below regulatory criteria. SCDHEC allows a 3-year MNA evaluation period. If MNA is not demonstrated as effective in this period, more active remediation may be warranted. For the purposes of this FS, MNA and associated monitoring are assumed to last for 10 years in regolith groundwater.

Effectiveness

This alternative is expected to be protective of human health and the environment and meet the established RAOs. The M/T/V of contaminants in soil would be reduced significantly through select excavation and offsite disposal and SVE. The M/T/V of contaminants in groundwater would also be significantly reduced through thermal-enhanced MPE and air sparging. The bedrock containment system will not reduce the toxicity and volume of contaminants in bedrock groundwater, but it will limit mobility and concentrations would be expected to decline shortly following source treatment in the regolith zone. Monitoring proposed under this alternative would allow SCDHEC to assess the ongoing threats to human health and the environment posed by the affected media at the site.

Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional and specialized construction methods. Equipment, services, and personnel should be readily available from select vendors.

Cost

The costs for this alternative are the lowest of the combination alternatives and low to moderate when comparing to combinations of individual groundwater and soil alternatives. Capital costs for this alternative include extraction well installation, institutional controls, excavation, SVE well and system installation, thermal treatment, MPE wells, and air sparging well and system installation. O&M costs also exist and include media monitoring, SVE/air sparging system O&M, treatment system O&M, and MPE system O&M.

5.3.3 Alternative 3 – Hydraulic Containment, SVE, Thermal-Enhanced MPE, and In Situ Thermal Treatment

Description

This alternative involves hydraulic containment in the regolith and bedrock zones, SVE in the Burn Pit Area, thermal-enhanced MPE in the Fuel Oil Area, and in situ thermal treatment for both soil and groundwater. Specifically, this alternative includes the following components:

- Institutional controls as described in Section 5.2.2.
- Excavation and offsite disposal of metals exceeding RGs outside of VOC treatment areas, as described in Section 5.2.3.
- Hydraulic containment with onsite physical/chemical treatment for the regolith and bedrock hydraulic zones, as described in Section 5.1.3 except that the two most southern proposed regolith extraction wells are not included under this alternative.
- SVE in the Burn Pit Area, if necessary, as described in Section 5.3.1.
- Thermal-enhanced MPE for the Fuel Oil Area, as described in Section 5.3.1.
- In situ thermal treatment for select areas to treat for VOCs in soil and regolith groundwater. This component is described further below.
- Groundwater and surface water monitoring, as described in Section 5.1.2.

Figure 5-6 outlines the treatment areas for this alternative and the associated technologies. For the purposes of this FS, ERH has been assumed as the thermal treatment technology. However, if this alternative is selected, other technologies, such as thermal conductive heating, will be evaluated during pre-design activities to determine the most effective approach for this site.

Under this combination alternative, soil and regolith groundwater treatment using in situ thermal will be applied to the areas of higher VOC concentrations to quickly reduce the contaminant mass to relatively low concentrations that will be protective of human health via direct contact. In general, these are the areas exceeding 1,000 mg/kg total VOCs in soil and 1,000 ug/L total VOCs in groundwater. If this alternative is selected, these areas will be refined during remedial design based on one or more of the following factors: pre-design investigation results, fate and transport modeling, and pilot-scale test results.

The direct in situ thermal treatment will not be intended to lower the VOC concentrations at all locations to below the RGs for soil and groundwater. However, one characteristic of this technology is to accomplish remediation beyond the direct treatment zone through enhanced degradation and volatilization. As a result, groundwater containment will be necessary for both the regolith and bedrock zones. For the purposes of this analysis, the indirect treatment zone for in situ thermal treatment is assumed to be a 50-foot perimeter surrounding each treatment zone. As indicated on Figure 5-6, this zone covers the area outside of the Fuel Oil Area exceeding the soil RGs.

Following certain components of this remedial alternative, MNA may be warranted to assess further attenuation from areas that did not reach RGs and to ensure that COC concentrations in all treated areas remain below regulatory criteria. SCDHEC allows a 3-year MNA evaluation period. If MNA is not demonstrated as effective in this period, more active remediation may be warranted. For the purposes of this FS, MNA and associated monitoring are assumed to last for 10 years in regolith groundwater.

Effectiveness

Based on the total mass removal and proven ability of in situ thermal remediation by ERH to remediate high concentration VOCs in soil and groundwater quickly, this alternative is expected to be the most protective of human health and the environment when compared to the other remedial alternatives. Thermal remediation would significantly reduce the M/T/V of contaminants in both soil and groundwater in a short timeframe. While thermal remediation is typically not used to treat groundwater in bedrock, bedrock groundwater concentrations would be expected to decline significantly once thermal treatment in the regolith and vadose zones was complete. The hydraulic containment system would limit the mobility of contaminants that remain in regolith and bedrock groundwater.

Implementability

Implementation of this alternative is considered technically feasible and would require specialty construction methods. The number of vendors providing thermal remediation services is limited but sufficient to promote competition. Those that do exist have demonstrated a high level of success on several projects.

Cost

The costs for this alternative falls between the other two combination alternatives. The costs are also moderate when comparing to combinations of individual groundwater and soil alternatives. In general, in situ thermal treatment costs are high compared to other remedial alternatives. However, the treatment area proposed for this alternative is slightly smaller than for some of the other alternatives. This allows the cost to fall in the moderate range. The identified treatment area still provides a high level of contaminant reduction. Additionally, the actual costs at completion for in situ thermal treatment tend to be less variable than for other alternatives because the technology is less susceptible to variable field conditions.

Capital costs for this alternative include extraction well installation, thermal well, SVE well, and thermal treatment system installation, groundwater treatment system upgrades, institutional controls, and limited excavation. Although relatively short term, O&M costs also exist and include media monitoring and O&M for the thermal remediation system. Power is one of the primary factors why in situ thermal treatment can be costly, and power costs are driven by system operation duration. Careful planning, design, and understanding of existing conditions are needed to estimate the duration of thermal treatment.

Section 6
Detailed Analysis of Alternatives

The objective of this section is to evaluate each of the remedial alternatives identified in Section 5 on the basis of the threshold and balancing criteria defined in the NCP. At the end of the section, the alternatives are compared to each other using the NCP criteria.

6.1 Evaluation Criteria

In accordance with the NCP, the retained alternatives were evaluated against the nine criteria described below. To establish priority among these criteria, they are separated into three groups. The first two criteria listed are threshold criteria and must be satisfied by the remedial action alternative being considered. The next five criteria are secondary criteria used as balancing criteria among those alternatives that satisfy the threshold criteria. The last two criteria are not evaluated during the FS. State acceptance is evaluated by SCDHEC during the review and approval of this FS report. Community acceptance is evaluated by SCDHEC during the public comment period of the proposed plan, and a SCDHEC responsiveness summary is incorporated into the Record of Decision.

6.1.1 Overall Protection of Human Health and the Environment

Each alternative was assessed to determine whether it can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site through eliminating, reducing, or controlling exposures to levels established during development of RAOs. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

6.1.2 Compliance with ARARs

Each alternative was assessed to determine whether it would attain ARARs under federal and state environmental or facility siting laws, or provide grounds for invoking one of the waivers.

6.1.3 Long-Term Effectiveness and Permanence

Each alternative was assessed for the long-term effectiveness and permanence it presents, along with the degree of certainty that the alternative will prove technically successful. Factors considered as appropriate included the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their M/T/V, and propensity to bioaccumulate.

- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative; and the potential exposure pathways and risks posed should the remedial action need replacement.

6.1.4 Reduction of M/T/V Through Treatment

The degree to which each alternative employs recycling or treatment that reduces M/T/V was assessed, including how treatment is used to address the principal threats posed by the site. Factors considered as appropriate included the following:

- Treatment or recycling processes the alternatives employ and the materials they will treat.
- Amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.
- Degree of expected reduction of M/T/V of the waste due to treatment or recycling and the specification of which reduction(s) are occurring.
- Degree to which the treatment is irreversible.
- Type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents.
- Degree to which treatment reduces the inherent hazards posed by principal threats at the site.

6.1.5 Short-Term Effectiveness

The short-term effectiveness of each alternative was assessed considering the following:

- Short-term risks that might be posed to the community during implementation of an alternative.
- Potential risks to workers during remedial action and the effectiveness and reliability of protective measures.
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.
- Time until protection is achieved.

6.1.6 Implementability

The ease or difficulty involved in implementing each alternative was assessed by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (e.g., offsite disposal).

- Availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists; provisions to ensure any necessary additional resources; the availability of services and materials; and the availability of prospective technologies.

6.1.7 Cost

The types of costs that were assessed included:

- Capital costs, including both direct and indirect costs.
- Annual O&M costs.
- Net present worth of capital and O&M costs.

The present worth of each alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life.

The present worth analysis was performed on all remedial alternatives using a 3.5% inflation rate and a 7% discount rate over a period of 30 years. The cost estimates presented in this FS are conceptual level estimates and therefore have an expected accuracy of -30% to +50%. Appendix A contains spreadsheets showing each component of the present worth costs.

6.1.8 State Acceptance

Assessment of state concerns will be completed in the review and approval of this FS report by SCDHEC. The State's concerns that shall be assessed include the following:

- State comments on the RAOs.
- State's position and key concerns related to the remedial action alternatives.

6.1.9 Community Acceptance

Community acceptance is evaluated by presenting the FS results to the public and obtaining public input. This assessment will not be completed until comments on the proposed plan are received.

6.2 Analysis of Alternatives

Summaries of the evaluation criteria for each alternative in groundwater and soil are presented in **Table 6-1** and **Table 6-2**, respectively. **Table 6-3** presents a summary of evaluation criteria for each groundwater/soil combination alternative. A comparative analysis of how the alternatives satisfy or do not satisfy each of the criteria is presented in the remaining subsections. Additional details regarding the assumptions for each alternative are presented in Section 5 and the cost estimates in Appendix A.

6.2.1 Groundwater Alternatives

6.2.1.1 Alternative 1 – No Action

Overall Protection of Human Health and the Environment

Because remedial actions would not be initiated as part of this alternative, it will not provide any increased protection to human health or the environment. Periodic assessments conducted as part of this alternative would provide the data necessary to evaluate whether future action is necessary.

Compliance with ARARs

Compliance with ARARs may be achieved in certain areas of the site, including in groundwater where low concentrations of constituents were detected below applicable regulatory criteria. However, this alternative will not result in achieving the chemical-specific ARARs for waste located within the groundwater locations with constituent concentrations above RGs. Location- and action-specific ARARs do not apply to this alternative since remedial actions would not be conducted.

Long-Term Effectiveness and Permanence

This alternative has no long-term effectiveness and permanence as impacted material remains on site. A review/reassessment of the conditions at the site would be performed periodically to ensure that the remedy does not become a greater risk to human health and the environment.

Reduction of M/T/V Through Treatment
No reductions in contaminant M/T/V are likely under this alternative beyond what may already be occurring.

Short-Term Effectiveness
Since no further remedial actions would be implemented at the site, this alternative poses no short-term risks to onsite workers, the environment, or the nearby community.

Implementability
This alternative requires no further action beyond periodic assessments and could be implemented immediately.

Cost
The total present worth cost for this alternative is $420,000, which covers assessments of conditions at 5-year intervals. Detailed cost estimates are presented in Appendix A.

6.2.1.2 Alternative 2 – Institutional Controls & Long-Term Monitoring

Overall Protection of Human Health and the Environment
This alternative would be effective in protecting human health because it would reduce access to the site, and thus limit potential exposures. Access to the site would be limited through controls such as fencing, and deed restrictions would prohibit future use of the site for residential purposes and future use of groundwater. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs
Compliance with ARARs may be achieved in certain groundwater areas where low concentrations of constituents were detected below applicable regulatory criteria. However, this alternative will not result in achieving the chemical-specific ARARs for areas with groundwater concentrations above RGs. Location- and action-specific ARARs for this alternative would be limited since remedial activities only include site perimeter fencing.

Long-Term Effectiveness and Permanence
This alternative is expected to be effective as long as institutional controls are maintained and monitoring is conducted to ensure that additional risks do not arise. However, this alternative would not result in minimizing potential contaminant migration to groundwater and/or surface water. Long-term monitoring (of media and institutional controls) would be conducted to determine any ongoing risks that the site poses to human health and the environment.

Reduction of M/T/V Through Treatment
No reductions in contaminant M/T/V will occur under this alternative beyond what may already be occurring.

Short-Term Effectiveness
Remedial actions at the site under this alternative would likely be limited to perimeter fencing, which is already installed at the site. Thus, this alternative poses minimal short-term risks to onsite workers, the environment, or the nearby community.

Implementability
This alternative could be implemented immediately since materials and monitoring equipment are readily available and procedures are in place.

Cost
The total present worth cost of this alternative is $1.7 million. The capital costs include implementing deed restrictions. The O&M costs include long-term monitoring and site inspections and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.1.3 Alternative 3 – Hydraulic Containment & Onsite Physical/Chemical Treatment

Overall Protection of Human Health and the Environment
This hydraulic containment alternative is expected to be protective of human health and the environment because it prevents contaminated groundwater from mobilizing to other areas of the site (and off site). Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs
This alternative will likely achieve location- and action-specific ARARs. Chemical-specific ARARs are not expected to be met because contaminants would persist above chemical-specific ARARs beyond the 30-year evaluation period in both the regolith and bedrock zones.

Long-Term Effectiveness and Permanence
This alternative is expected to be partially effective in meeting the RAOs derived for the site. It would limit future releases of contaminants through hydraulic controls and would limit access to contaminants through institutional controls. Long-term O&M of the extraction and treatment system would be required.

Reduction of M/T/V Through Treatment
This alternative would be effective in reducing the mobility but not the toxicity or volume of contaminants at the site. Groundwater RGs would not be met on site, and only a small portion of the contaminant mass would be extracted and treated through the containment system.

Short-Term Effectiveness
The construction phase of this alternative would likely be accomplished within a few months. Therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts associated with this alternative include disturbance of soils during well installation and trench construction (for piping to treatment

system). The groundwater treatment system would likely continue to be operated for 30 years.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability
Extraction well installation can be implemented immediately. No significant construction issues are expected to be encountered. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost
The total present worth cost of this alternative is $7.7 million. The capital costs for this alternative include implementing deed restrictions, installing regolith and bedrock extraction wells, and connecting the wells to the treatment system. The O&M costs include treatment system O&M, monitoring, site inspections, and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.1.4 Alternative 4 – In Situ Chemical Oxidation, Dual-Phase Extraction, and Bedrock Extraction

Overall Protection of Human Health and the Environment
Successful implementation of this alternative would reduce risks to human health and the environment and meet RAOs by treatment of regolith contaminated groundwater (toxicity and volume reduction), containment of bedrock groundwater (mobility reduction), and institutional controls.

Compliance with ARARs
This alternative will likely achieve chemical-specific ARARs in the regolith but not initially in bedrock groundwater. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase. At a minimum, these are expected to include an underground injection control permit.

Long-Term Effectiveness and Permanence
This alternative is expected to be effective in meeting the RAOs derived for the site. It will reduce contaminant concentrations in regolith groundwater and limit the mobility of contaminants in bedrock. Long-term monitoring (of media and institutional controls) would be conducted to determine any ongoing risks that the site poses to human health and the environment.

Reduction of M/T/V Through Treatment

This alternative would be effective in reducing the toxicity and volume of contaminants by performing in situ chemical oxidation and dual-phase extraction in regolith groundwater. In bedrock, mobility reduction would be achieved through hydraulic controls. Toxicity and volume should decline in bedrock after removing contaminants in the regolith zone.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within 1-2 years. However, the bedrock containment and DPE system construction would be completed within a few months. The injection system would continue to be operated, but this process option does not include long-term exposure to groundwater (except during monitoring well sampling). However, handling of the oxidant poses some risks to site workers. Therefore, impacts associated with construction would likely be moderate. Short-term impacts associated with this alternative include disturbance of soils during well construction and piping trench installation.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Injection and extraction well construction use standard practices and are readily implemented. Both the chemical oxidation and DPE processes require bench- and pilot-scale testing prior to full-scale implementation. No significant construction issues are expected to be encountered. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost

The total present worth cost of this alternative is $32 million. The capital costs for this alternative include implementing deed restrictions, installing chemical oxidation and DPE injection wells, performing chemical oxidation (three events) and DPE processes, installing bedrock extraction wells, and connecting the wells to the treatment system. The O&M costs include treatment system O&M, monitoring, site inspections, and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.1.5 Alternative 5 – Air Sparging, Dual-Phase Extraction, and Bedrock Extraction

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would reduce risks to human health and the environment and meet RAOs by treatment of regolith contaminated groundwater (toxicity and volume reduction), containment of bedrock groundwater (mobility reduction), and institutional controls.

Compliance with ARARs
This alternative will likely achieve chemical-specific ARARs in the regolith but not initially in bedrock groundwater. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase. At a minimum, these are expected to include an underground injection control permit.

Long-Term Effectiveness and Permanence
This alternative is expected to be effective in meeting the RAOs derived for the site. It will reduce contaminant concentrations in regolith groundwater and limit the mobility of contaminants in bedrock. Long-term monitoring (of media and institutional controls) would be conducted to determine any ongoing risks that the site poses to human health and the environment.

Reduction of M/T/V Through Treatment
This alternative would be effective in reducing the toxicity and volume of contaminants by performing air sparging and dual-phase extraction in regolith groundwater. In bedrock, mobility reduction would be achieved through hydraulic controls. Toxicity and volume should decline in bedrock after removing contaminants in the regolith zone.

Short-Term Effectiveness
The construction phase of this alternative would likely be accomplished within 2-3 years. However, the bedrock containment and DPE system construction would be completed within a few months. The air sparging system would continue to be operated, and exposure to extracted vapors during operation is possible. Therefore, impacts associated with construction would likely be low to moderate. Short-term impacts associated with this alternative include disturbance of soils during well construction and piping trench installation.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures including regular air monitoring. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability
Injection and extraction well construction use standard practices and are readily implemented. Both the air sparging and DPE processes require bench- and pilot-scale testing prior to full-scale implementation. No significant construction issues are expected to be encountered. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost
The total present worth cost of this alternative is $16.7 million. The capital costs for this alternative include implementing deed restrictions; installing air sparging, DPE,

and SVE wells; performing the air sparging and DPE processes; installing bedrock extraction wells; and connecting the wells to the treatment system. Capital costs for this alternative would be reduced if this alternative is used in combination with SVE as the soil remedial alternative. The O&M costs include treatment system O&M, monitoring, site inspections, and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.1.6 Alternative 6 – Permeable Reactive Barrier, Dual-Phase Extraction, and Bedrock Extraction

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would reduce risks to human health and the environment by treatment of regolith contaminated groundwater (toxicity and volume reduction) prior to migrating off site, containment of bedrock groundwater (mobility reduction), and institutional controls. This alterative would not provide treatment in areas where groundwater concentrations are the highest.

Compliance with ARARs

This alternative will likely achieve chemical-specific ARARs in the regolith prior to moving off site but not in regolith or bedrock groundwater on site. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence

This alternative is expected to be effective in meeting the RAOs derived for the site. It will minimize contaminant concentrations in regolith groundwater that may be or could migrate off site and limit the mobility of contaminants in bedrock. Long-term monitoring (of media and institutional controls) would be conducted to determine any ongoing risks that the site poses to human health and the environment.

Reduction of M/T/V Through Treatment

This alternative would only be effective in reducing the toxicity and volume of contaminants migrating into the barrier wall and through dual-phase extraction in the fuel oil area. It would not be expected to meet groundwater RGs on site. In bedrock, mobility reduction would be achieved through hydraulic controls. Limited toxicity and volume reductions would be expected in bedrock.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished in less than one year. However, the bedrock containment and DPE system construction would be completed within a few months. Installation of the permeable reactive barrier could expose workers to soil and groundwater contamination. Therefore, impacts associated with construction would likely be moderate to high. Short-term impacts associated with this alternative include disturbing soils and groundwater during wall construction and disturbing soils during well construction and piping trench installation.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability
Extraction well construction uses standard practices and is readily implemented. However, while vendors have reported that conventional construction methods can be used up to 80 feet, constructing a 60-foot deep wall involves a higher level of difficulty than most of the other remedial alternatives. Construction issues may be also be encountered with the presence of several large boulders in the area of the permeable barrier wall.

Both the permeable reactive barrier wall and the DPE process require bench- and pilot-scale testing prior to full-scale implementation. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost
The total present worth cost of this alternative is $16.9 million. The capital costs for this alternative include implementing deed restrictions; installing the permeable reactive barrier and DPE injection wells; performing the DPE process; installing bedrock extraction wells; and connecting the wells to the treatment system. The O&M costs include treatment system O&M, monitoring, site inspections, and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.2 Soil Alternatives

6.2.2.1 Alternative 1 – No Action

Overall Protection of Human Health and the Environment
Because remedial actions would not be initiated as part of this alternative, it will not provide any increased protection to human health or the environment. Periodic assessments conducted as part of this alternative would provide the data necessary to evaluate whether future action is necessary.

Compliance with ARARs
Compliance with ARARs may be achieved in certain areas of the site where low concentrations of constituents were detected below applicable regulatory criteria. However, this alternative will not result in achieving the chemical-specific ARARs within the soil areas of concern. Location- and action-specific ARARs do not apply to this alternative since remedial actions would not be conducted.

Long-Term Effectiveness and Permanence
This alternative has no long-term effectiveness and permanence as impacted material remains on site under this alternative. A review/reassessment of the conditions at the

site would be performed periodically to ensure that the remedy does not become a greater risk to human health and the environment.

Reduction of M/T/V Through Treatment
No reductions in contaminant M/T/V occur under this alternative beyond what may already be occurring.

Short-Term Effectiveness
Since no further remedial actions would be implemented at the site, this alternative poses no short-term risks to onsite workers, the environment, or the nearby community.

Implementability
This alternative requires no further action beyond periodic assessments and could be implemented immediately.

Cost
The total present worth cost for this alternative is $418,000, which covers assessments of conditions at 5-year intervals. Detailed cost estimates are presented in Appendix A.

6.2.2.2 Alternative 2 – Institutional Controls

Overall Protection of Human Health and the Environment
This alternative would be effective in protecting human health because it would reduce access to the site, and thus limit potential exposures. Access to the site would be limited through controls such as fencing, and deed restrictions would prohibit future use of the site for residential purposes and future use of groundwater. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs
Compliance with ARARs may be achieved in certain areas of the site where low concentrations of constituents were detected below applicable regulatory criteria. However, this alternative will not result in achieving the chemical-specific ARARs within the soil areas of concern. Location- and action-specific ARARs do not apply to this alternative since remedial actions would not be conducted.

Long-Term Effectiveness and Permanence
This alternative is expected to be effective as long as institutional controls are maintained and monitoring is conducted to ensure that additional threats do not arise. However, this alternative would not result in minimizing potential contaminant migration to groundwater and/or surface water. Long-term monitoring (of media and institutional controls) would be conducted to determine any ongoing risks that the site poses to human health and the environment.

Reduction of M/T/V Through Treatment
No reductions in contaminant M/T/V occur under this alternative beyond what may already be occurring.

Short-Term Effectiveness
Remedial actions at the site under this alternative would likely be limited to perimeter fencing. Thus, this alternative poses minimal short-term risks to onsite workers, the environment, or the nearby community.

Implementability
This alternative could be implemented immediately since materials and monitoring equipment are readily available and procedures are in place.

Cost
The total present worth cost of this alternative is $604,000. The capital costs include implementing deed restrictions. The O&M costs include long-term monitoring, site inspections, and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.2.3 Alternative 3 – Soil Excavation and Offsite Disposal

Overall Protection of Human Health and the Environment
Excavating the soil areas of concern and disposing of material in a regulated landfill off site is expected to be protective of human health and the environment because it removes source material, thus reducing access to contaminants and limiting future releases from the site to groundwater and surface water. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs
This alternative will likely achieve chemical-specific ARARs for a majority of the site since much or all of the source material will be removed. All location- and action-specific ARARs are expected to be met. Transportation of contaminated material would be conducted in accordance with applicable Department of Transportation hazardous material regulations, and disposal at an appropriate regulated landfill would be performed in accordance with other applicable location- and action-specific ARARs. The required state and federal permits will be evaluated during the remedial design phase. At a minimum, these are expected to include a National Pollutant Discharge Elimination System permit for construction activities.

Long-Term Effectiveness and Permanence
With the removal of contaminated soil areas, long-term public health and environmental threats would be minimal. Deed restrictions and institutional controls may still be required to limit access to any contaminants that remain on site.

Reduction of M/T/V Through Treatment
Soil excavation would effectively reduce the M/T/V of contaminants at the site. The contaminants are not treated, but they are removed from the site.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one year. Therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts associated with this alternative include disturbance and mobilization of soils during excavation and backfilling activities. Demolition of existing buildings may include risks for potential asbestos exposure. However, these potential short-term impacts could be mitigated during the construction phase using appropriate erosion and dust control methods.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during soil grading. Dust emissions would be monitored at the property boundaries, and fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, and noise.

Implementability

Soil excavation above the water table utilizes standard construction practices. No significant construction issues are expected to be encountered. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost

The total present worth cost of this alternative is $32.3 million. This cost assumes that 5% of excavated material will be classified as hazardous waste and require disposal at a permitted hazardous waste facility. The capital costs for this alternative are primarily related to excavating soil, building demolition, and environmental controls. The O&M costs include media monitoring. Detailed cost estimates are presented in Appendix A.

6.2.2.4 Alternative 4 – Source Containment

Overall Protection of Human Health and the Environment

Capping the entire footprint of the soil areas of concern with a solid waste cap according to SCDHEC regulations is expected to be protective of human health and the environment because it reduces access to contaminants in the soil and minimizes future releases of contaminants from the soil to groundwater. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs

This alternative does not remove or treat existing contaminants, so there will still be soil under the cap that does not meet chemical-specific ARARs. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence

While this alternative would limit the potential for direct human exposure to contaminated soil, the threat could return over the long term if cap integrity was compromised. Thus, the cap would need to be periodically inspected, and required maintenance would need to be implemented to maintain effectiveness.

The long-term effectiveness of this alternative would be enhanced by selecting the proper cover design and grading layout. In addition, access restrictions such as land use controls and fencing would be required to prevent land uses incompatible with the site; specifically, land uses that would compromise the cap should be precluded.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant mobility by isolating contaminants from receptor contact. While contaminant volume and toxicity would not be reduced, contaminant mobility would be reduced by installing the cap. Contaminant mobility is expected to be reduced to an extent that would result in overall risk reduction from all pathways and exposure routes.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within 1 or 2 years. Therefore, impacts associated with construction would likely be moderate in length. Short-term impacts associated with this alternative include disturbance and mobilization of soils during demolition, grading, and capping activities. However, these potential short-term impacts could be mitigated during the construction phase using appropriate erosion and dust control methods.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during soil grading. Dust emissions would be monitored at the property boundaries, and fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, and noise.

Implementability

Construction of a cap utilizes standard construction practices. No significant construction issues are expected to be encountered. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost

The total present worth cost of this alternative is $4.9 million. The capital costs include implementing deed restrictions, installing fencing, constructing run on controls, demolishing existing buildings in the cap footprint, and capping an area encompassing the soil areas of concern. The O&M costs include long-term monitoring, site inspections, and maintenance (including the cap). Detailed cost estimates are presented in Appendix A.

6.2.2.5 Alternative 5 – Soil Excavation and Onsite Ex Situ Treatment

Overall Protection of Human Health and the Environment

Excavating the soil areas of concern, treating of material on site, and replacing the treated soil into the excavation pits is expected to be protective of human health and the environment because it treats source material, thus removing contaminants and limiting future releases of contaminants from soil to groundwater and surface water. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs

This alternative will likely achieve chemical-specific ARARs for a majority of the site since much or all of the source material will be treated to below RGs. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence

With the removal of contaminants from soil via onsite treatment, long-term public health threats would be minimal. Deed restrictions and institutional controls may still be required to limit access to any contaminants that remain on site.

Reduction of M/T/V Through Treatment

Soil excavation and onsite treatment would effectively reduce the M/T/V of contaminants at the site.

Short-Term Effectiveness

The construction and treatment phase of this alternative would likely be accomplished within years. Impacts associated with construction and treatment are considered high compared to other remedial alternatives. Excavation and onsite treatment would require detailed planning and sequencing and would involve large open excavations. Short-term impacts associated with this alternative include disturbance and mobilization of soils during excavation and backfilling activities, possible mobilization of contaminants in open excavations, and multiple operations occurring on site at one time.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. Short-term air quality impacts to the surrounding environment may occur during soil grading and treatment. Dust emissions would be monitored at the property boundaries, and fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic. Air emissions during soil treatment would also be monitored and may require controls.

Implementability
Soil excavation above the water table utilizes standard construction practices. No significant construction issues are expected to be encountered. Because the volume of soil to be treated is so large, design and land use limitations would likely require that the soil is treated in 4-6 month phases. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost
The total present worth cost of this alternative is $24.5 million. The capital costs for this alternative are primarily related to excavating and treating soil, building demolition, and environmental controls. The O&M costs include media monitoring. Detailed cost estimates are presented in Appendix A.

6.2.2.6 Alternative 6A –Soil Vapor Extraction

Overall Protection of Human Health and the Environment
Treating the soil areas of concern in situ with SVE is expected to be protective of human health and the environment because it treats source material, thus removing contaminants and limiting future releases of contaminants from soil to groundwater and surface water. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs
This alternative will likely achieve chemical-specific ARARs for a majority of the site since much or all of the source material will be treated to below RGs. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence
With the removal of contaminants from soil via in situ SVE, long-term public health threats would be minimal. Deed restrictions and institutional controls may still be required to limit access to any contaminants that remain on site.

Reduction of M/T/V Through Treatment
In situ SVE would effectively reduce the M/T/V of contaminants at the site. This alternative assumes a treatment system for vapors.

Short-Term Effectiveness
The construction and treatment phase of this alternative would likely be accomplished within ten years (as five 2-year SVE events in different locations). Minimal contact with soil or groundwater is anticipated following well construction. However, contaminated soil gas can be a risk to workers during SVE activities. Therefore, risks associated with construction and treatment should be considered low to moderate. Short-term impacts associated with this alternative include disturbance and mobilization of soils during well installation activities. However, these potential short-term impacts could be mitigated during the construction phase using appropriate erosion and dust control methods.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures, including air monitoring. However, short-term air quality impacts to the surrounding environment may occur during SVE activities. Air monitoring would be performed at the property boundaries, and fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, and noise.

Implementability

SVE system installation involves standard construction practices. No significant construction issues are expected to be encountered. Treatability testing would be required prior to full-scale implementation. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost

The total present worth cost of this alternative is $9.5 million. The capital costs for this alternative are primarily related to installing SVE wells, SVE system O&M, and environmental controls. The O&M costs include site inspections and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.2.7 Alternative 6B –Thermal Enhanced Soil Vapor Extraction

Overall Protection of Human Health and the Environment

Treating the soil areas of concern in situ with thermal enhanced SVE is expected to be protective of human health and the environment because it treats source material, thus removing contaminants and limiting future releases of contaminants from soil to groundwater and surface water. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs

This alternative will likely achieve chemical-specific ARARs for a majority of the site since much or all of the source material will be treated to below RGs. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence

With the removal of contaminants from soil via in situ thermal enhanced SVE, long-term public health threats would be minimal. Deed restrictions and institutional controls may still be required to limit access to any contaminants that remain on site.

Reduction of M/T/V Through Treatment

In situ thermal enhanced SVE would effectively reduce the M/T/V of contaminants at the site. This alternative assumes a treatment system for vapors.

Short-Term Effectiveness
The construction and treatment phase of this alternative would likely be accomplished within five years. Minimal contact with soil or groundwater is anticipated following well construction. However, contaminated soil gas can be a risk to workers during SVE activities, and thermal enhanced SVE uses high voltage during treatment. Therefore, risks associated with construction and treatment should be considered moderate to high. Short-term impacts associated with this alternative include disturbance and mobilization of soils during well installation activities. However, these potential short-term impacts could be mitigated during the construction phase using appropriate erosion and dust control methods.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures, including air monitoring. However, short-term air quality impacts to the surrounding environment may occur during SVE and thermal treatment activities. Air monitoring would be performed at the property boundaries, and fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, and noise.

Implementability
Thermal enhanced SVE uses relatively standard construction practices. No significant construction issues are expected to be encountered. Treatability testing would be required prior to full-scale implementation. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost
The total present worth cost of this alternative is $45.5 million. The capital costs for this alternative are primarily related to installing thermal/SVE wells, SVE system O&M, and environmental controls. The O&M costs include site inspections and maintenance. Detailed cost estimates are presented in Appendix A.

6.2.3 Combination Groundwater and Soil Alternatives

6.2.3.1 Alternative 1 – Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Deep Soil Mixing

Overall Protection of Human Health and the Environment
Excavating Principal Threat Source Material (PTSM), performing SVE in the Burn Pit Area (if necessary based on additional assessment data to be collected), performing thermal-enhanced MPE in the Fuel Oil Area, and using deep soil mixing with oxidant in other VOC impacted areas is expected to be protective of human health and the environment because it removes the areas with the highest concentration of contaminants and treats source material using different techniques in the remaining soil impacted areas. Future releases of contaminants to groundwater and surface water would be reduced, and hydraulic containment of the regolith and bedrock

zones would limit the migration of contaminants that remain in groundwater. However, limited groundwater treatment is proposed under this alternative. The deep soil mixing will be applied to regolith groundwater with VOCs generally exceeding 1,000 ug/L. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs

This alternative will likely achieve chemical-specific ARARs for a majority of the impacted soil since much or all of the source material will be excavated and disposed off site or treated to below RGs. Chemical-specific ARARs may not be met for several years in regolith and bedrock zone groundwater though concentrations would be expected to decline with the treatment of source material in soil and the areas of higher regolith zone VOCs. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence

With the removal of contaminants from soil via excavation and onsite treatment, long-term public health threats would be minimal. Hydraulic containment is included to limit migration of contaminants to surface water and potential offsite receptors. Deed restrictions and institutional controls would still be required to limit access to any contaminants that remain on site, particularly in groundwater.

Reduction of M/T/V Through Treatment

Excavation and onsite treatment would effectively reduce the M/T/V of contaminants in soil. This alternative would also be effective in reducing the mobility of contaminants in groundwater where deep soil mixing is applied. However, groundwater extraction for containment will only partially reduce the toxicity and volume of contaminants in groundwater, particularly in the bedrock zone.

Short-Term Effectiveness

The construction and treatment phase of this alternative would likely be accomplished within approximately five years. Therefore, impacts associated with construction and treatment should be considered. Short-term impacts associated with this alternative include disturbance and mobilization of soils during excavation, well installation, and backfilling activities; exposure to soil gas during SVE and MPE activities; and exposure to oxidant during deep soil mixing. Additionally, demolition of existing buildings may include risks for potential asbestos exposure. Thermal treatment also uses high voltage, but operation is relatively straightforward after installation. Risks associated with construction and treatment should be considered moderate.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. Short-term air quality impacts to the surrounding environment may occur during soil grading and SVE activities. Air monitoring would be performed at the property boundaries, and fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, and noise.

Implementability
Excavation, SVE, and extraction well installation utilize standard construction practices. More specialized construction is required for the thermal-enhanced MPE and deep soil mixing, but no significant construction issues are expected to be encountered. Treatability testing would be required prior to full-scale implementation. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost
The total present worth cost of this alternative is approximately $43.2 million. The capital costs for this alternative include deed restrictions, SVE well and system installation, thermal enhanced MPE system installation and operation, deep soil mixing, excavation, offsite disposal, building demolition, extraction well installation, and environmental controls. Upgrades to the existing groundwater treatment system are also anticipated. The O&M costs include groundwater treatment system O&M, SVE system O&M, and media monitoring. Detailed cost estimates are presented in Appendix A.

6.2.3.2 Alternative 2 – Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Air Sparging

Overall Protection of Human Health and the Environment
This alternative is expected to be protective of human health and the environment. PTSM excavation and SVE will significantly reduce contaminant concentrations in soil, and thermal-enhanced MPE and air sparging with hydraulic containment will significantly reduce contaminant concentrations in groundwater. Monitoring proposed under this alternative would allow SCDHEC to evaluate whether additional actions need to be taken.

Compliance with ARARs
This alternative will likely achieve chemical-specific ARARs for a majority of the site in both soil and groundwater. RGs may not initially be met for bedrock groundwater since only containment is proposed, but the significant reductions in regolith and vadose zone concentrations should yield reductions in bedrock groundwater concentrations also. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence
This alternative is expected to be effective in meeting the RAOs derived for the site. With the removal of contaminants from both soil and regolith groundwater, long-

term public health threats would be minimal. Long-term monitoring (of media and institutional controls) would identify any ongoing risks that the site poses to human health and the environment.

Reduction of M/T/V Through Treatment

This alternative would be effective in reducing the M/T/V of contaminants in both soil and regolith groundwater. The mobility of contaminants in bedrock groundwater would also be reduced, and toxicity and volume of contaminants should decline in bedrock after removing contaminants in the regolith and vadose zones.

Short-Term Effectiveness

The construction and treatment phase of this alternative would likely be accomplished within 10 years. Therefore, impacts associated with construction and treatment should be considered. Short-term impacts associated with this alternative include disturbance and mobilization of soils during excavation, well installation, and backfilling activities; and exposure to soil gas during air sparging and SVE activities. Additionally, thermal treatment uses high voltage, but operation is relatively straightforward after installation. Risks associated with construction and treatment should be considered moderate.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. Short-term air quality impacts to the surrounding environment may occur during soil grading and SVE activities. Air monitoring would be performed at the property boundaries, and fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, and noise.

Implementability

All technologies proposed for this alternative utilize standard construction practices. More specialized construction is required for the thermal-enhanced MPE, but no significant construction issues are expected to be encountered. Treatability testing would be required prior to full-scale implementation. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost

The total present worth cost of this alternative is $29 million. The capital costs for this alternative include deed restrictions, air sparging well and system installation, SVE well and system installation, thermal-enhanced MPE system installation and operation, excavation, offsite disposal, extraction well installation, and environmental controls. The O&M costs include groundwater treatment system O&M, SVE/air sparging system O&M, and media monitoring. Detailed cost estimates are presented in Appendix A.

6.2.3.3 Alternative 3 – Hydraulic Containment, SVE, Thermal-Enhanced MPE, and In Situ Thermal Treatment

Overall Protection of Human Health and the Environment

This alternative is expected to be the most protective of human health and the environment when compared to the other alternatives and applied to the same areas of concern. In situ thermal treatment is a demonstrated technology for multiple chemical types and for yielding substantial contaminant concentration reductions.

Compliance with ARARs

This alternative will likely achieve chemical-specific ARARs for a majority of the site in both soil and groundwater. RGs may not initially be met for bedrock groundwater since only containment is proposed, but the significant reductions in regolith and vadose zone concentrations should yield reductions in bedrock groundwater concentrations also. All location- and action-specific ARARs are expected to be met. The required state and federal permits will be evaluated during the remedial design phase.

Long-Term Effectiveness and Permanence

This alternative is expected to be effective in meeting the RAOs derived for the site. With the removal of contaminants from both soil and regolith groundwater, long-term public health threats would be minimal. Long-term monitoring (of media and institutional controls) would identify any ongoing risks that the site poses to human health and the environment.

Reduction of M/T/V Through Treatment

This alternative would be effective in reducing the M/T/V of contaminants in both soil and regolith groundwater. The mobility of contaminants in bedrock groundwater would also be reduced, and toxicity and volume of contaminants should decline in bedrock after thermal treatment in the regolith and vadose zones.

Short-Term Effectiveness

The construction and treatment phase of this alternative would likely be accomplished within five years. Minimal contact with soil or groundwater is anticipated following well construction. However, if not properly controlled, vapors from thermal treatment could be a risk to workers. Thermal treatment also uses high voltage, but operation is relatively straightforward after installation. Risks associated with construction and treatment should be considered moderate.

Onsite workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. Short-term air quality impacts to the surrounding environment may occur during thermal treatment. Other potential short-term impacts to the surrounding area could include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

In situ thermal treatment has been demonstrated successfully on several sites and utilizes standard construction practices combined with more specialized equipment. However, the number of vendors for each thermal technology type is limited. Additionally, more data collection will be necessary to accurately estimate cost since cost is very sensitive to the number of months of operation needed. No significant construction issues are expected to be encountered. Associated permits would be obtained from SCDHEC prior to implementation of this alternative.

Cost

The total present worth cost of this alternative is $35.9 million. The capital costs for this alternative include deed restrictions, thermal treatment well and system installation, thermal treatment (including power), and extraction well installation. The O&M costs include groundwater treatment system O&M, SVE system O&M, and media monitoring. Detailed cost estimates are presented in Appendix A.

6.3 Comparative Analysis of Alternatives

This section presents a comparative analysis of the alternatives described above based on the threshold and balancing evaluation criteria. **Table 6-4** and **Table 6-5** present the ranking scores for each alternative and evaluation criterion for groundwater and soil, respectively. For the combination alternatives, the tables reflect ranking scores for only the groundwater (Table 6-4) or soil (Table 6-5) components of that alternative. Each alternative's performance against the criteria (except for present worth) was ranked on a scale of 0 to 5, with 0 indicating that none of the criterion's requirements were met and 5 indicating that all of the requirements were met. The ranking scores are not intended to be additive, but rather are summary indicators of each alternative's performance against the criteria. The ranking scores combined with the present worth costs provide the basis for comparison among alternatives.

Section 7
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Figures

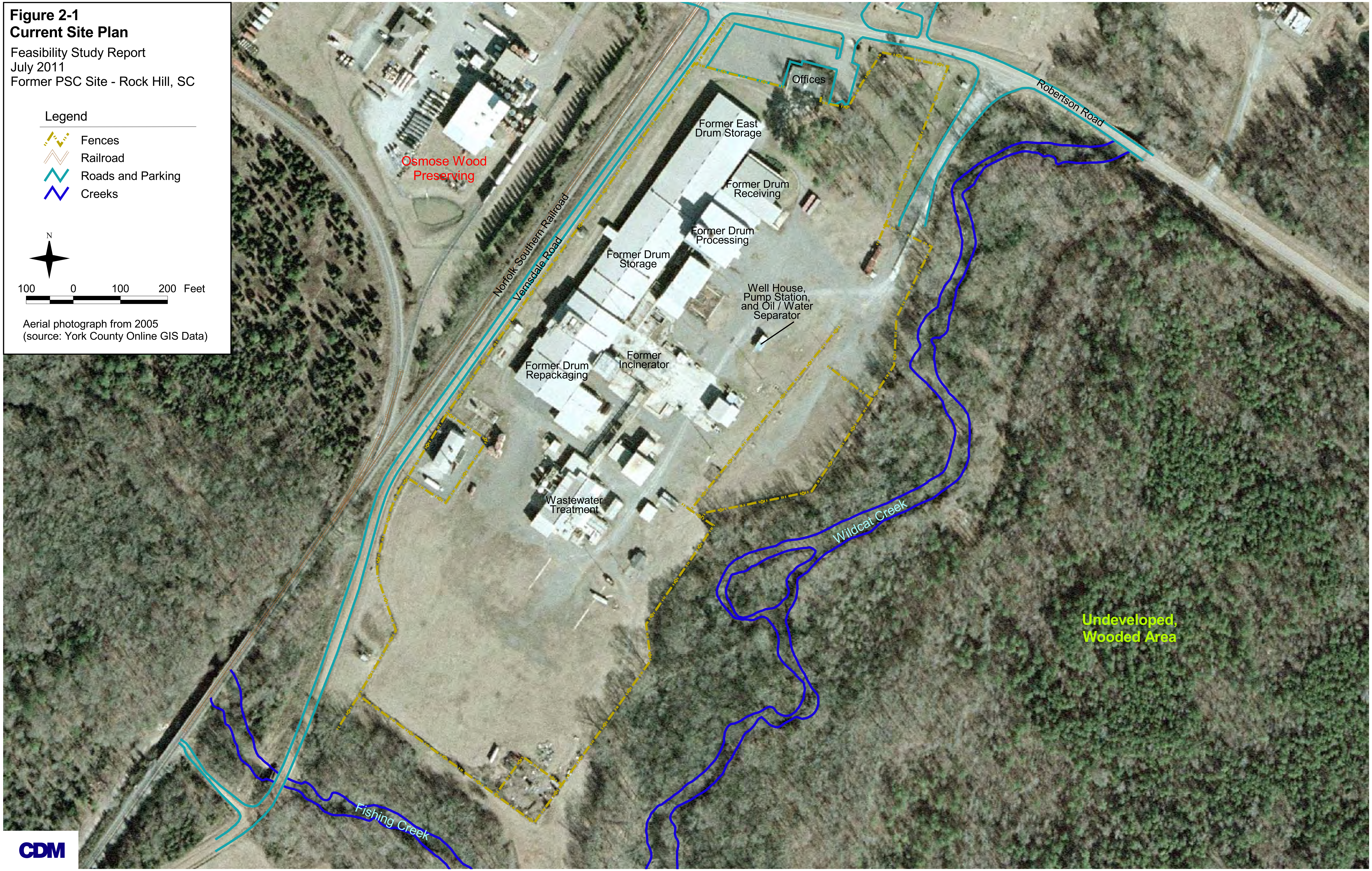


Figure 2-1
Current Site Plan
Feasibility Study Report
July 2011
Former PSC Site - Rock Hill, SC

Figure 2-2
Areas of Concern

Feasibility Study Report
July 2011
Former PSC Site - Rock Hill, SC

Legend

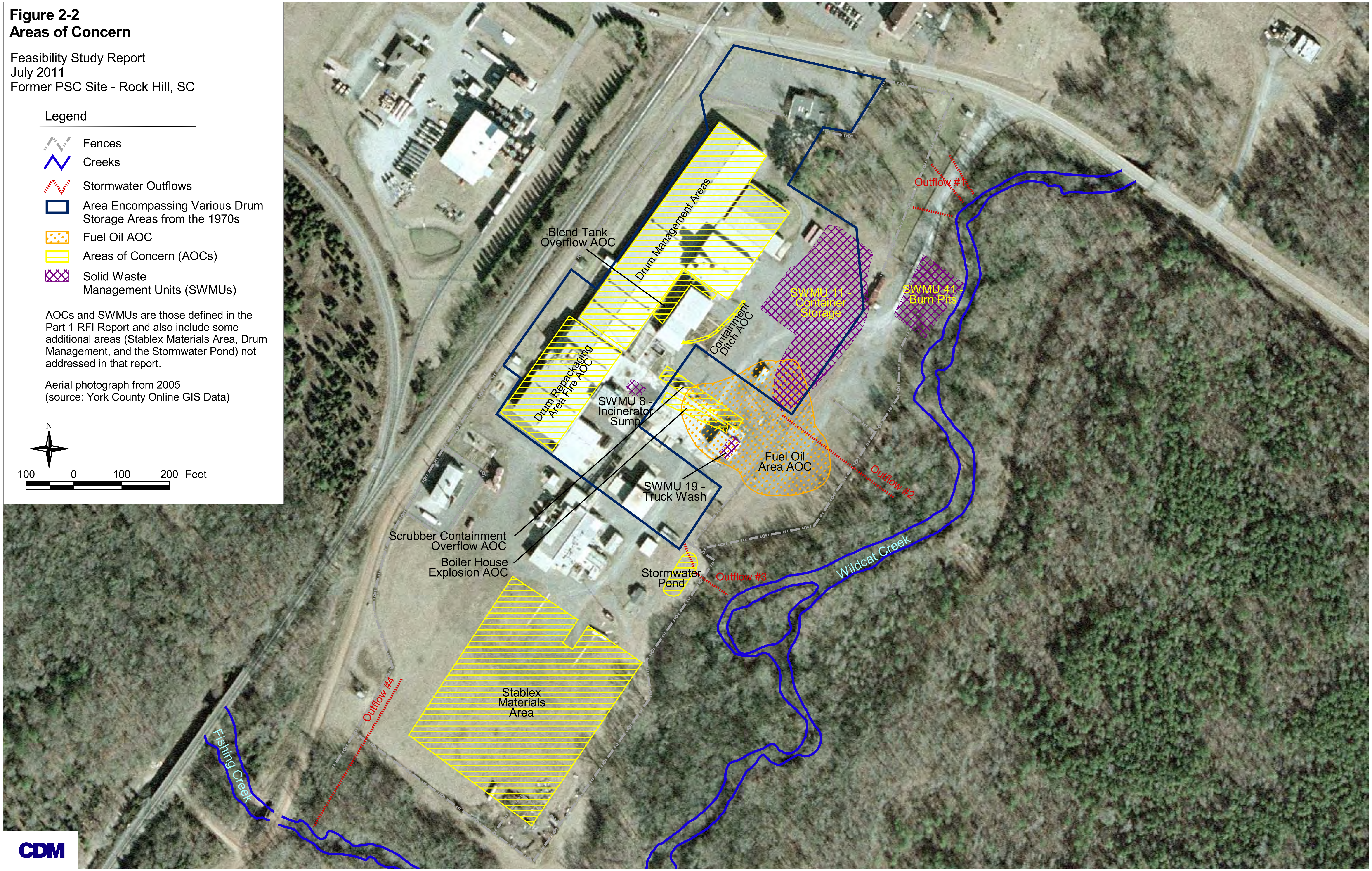
- Fences
- Creeks
- Stormwater Outflows
- Area Encompassing Various Drum Storage Areas from the 1970s
- Fuel Oil AOC
- Areas of Concern (AOCs)
- Solid Waste Management Units (SWMUs)

AOCs and SWMUs are those defined in the Part 1 RFI Report and also include some additional areas (Stablex Materials Area, Drum Management, and the Stormwater Pond) not addressed in that report.

Aerial photograph from 2005
(source: York County Online GIS Data)

N

100 0 100 200 Feet



CDM

Figure 2-3
Soil Areas of Concern
Feasibility Study Report
July 2011
Former PSC Site, Rock Hill, South Carolina

CDM

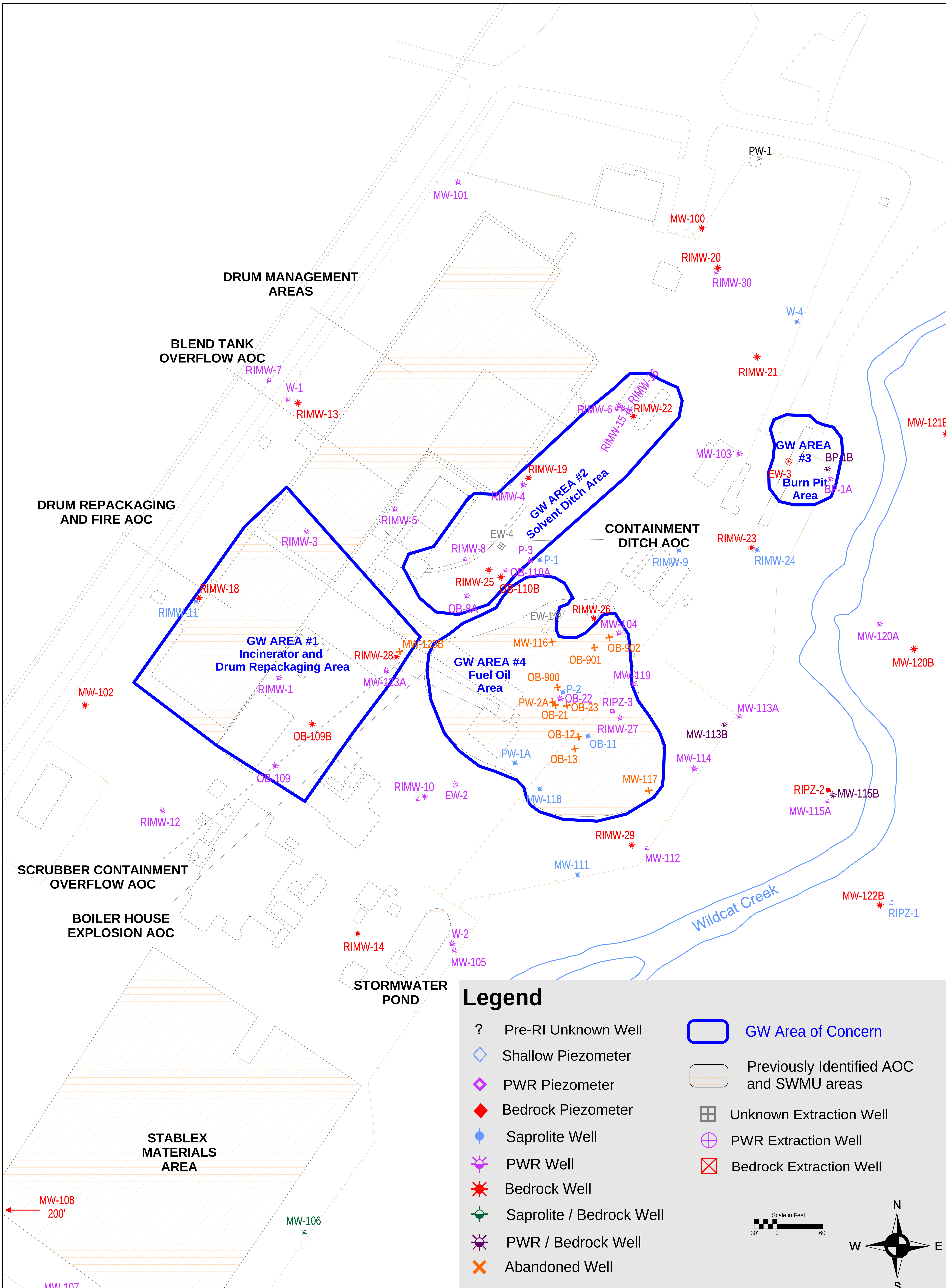
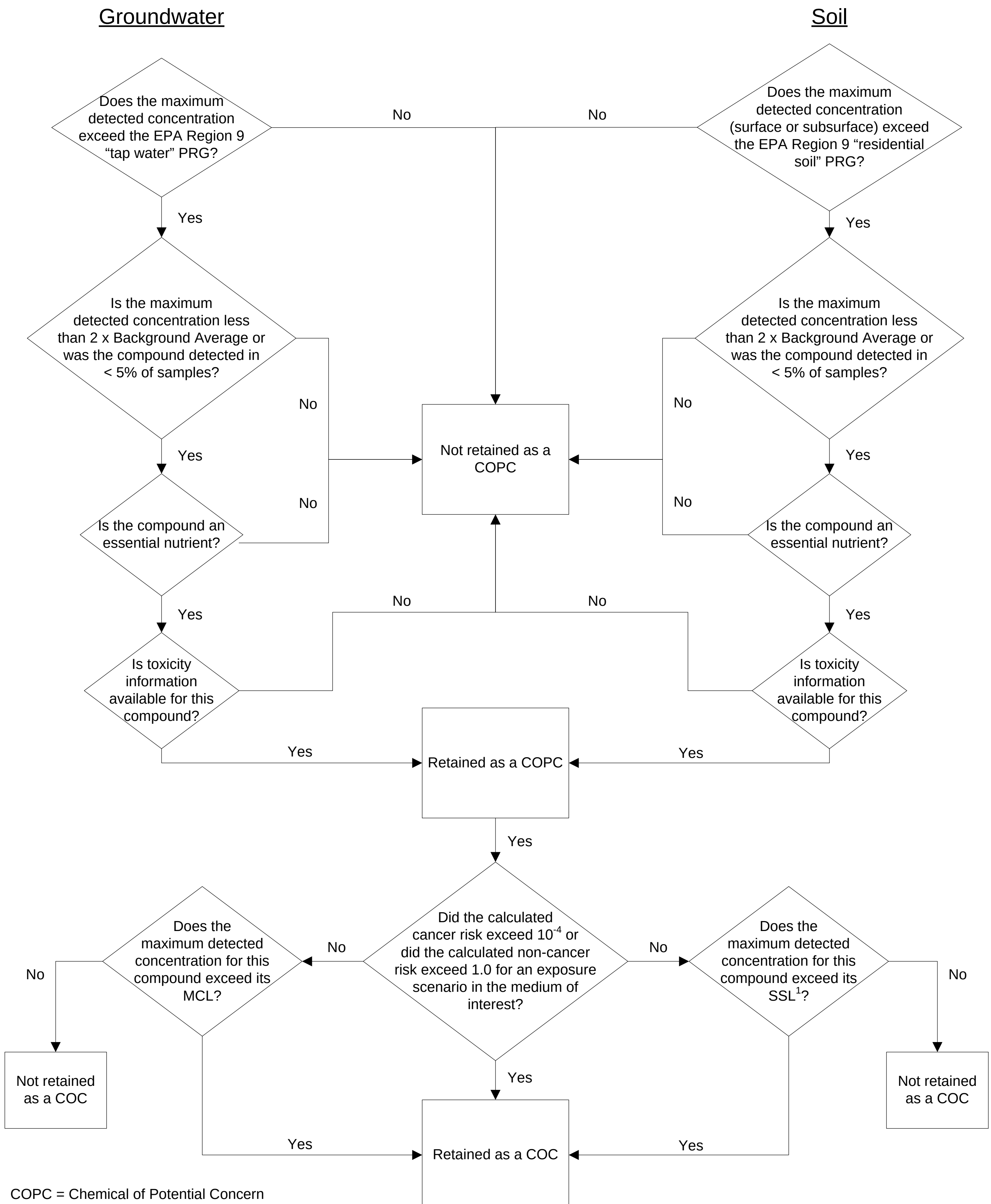


Figure 2-4
Groundwater Areas of Concern

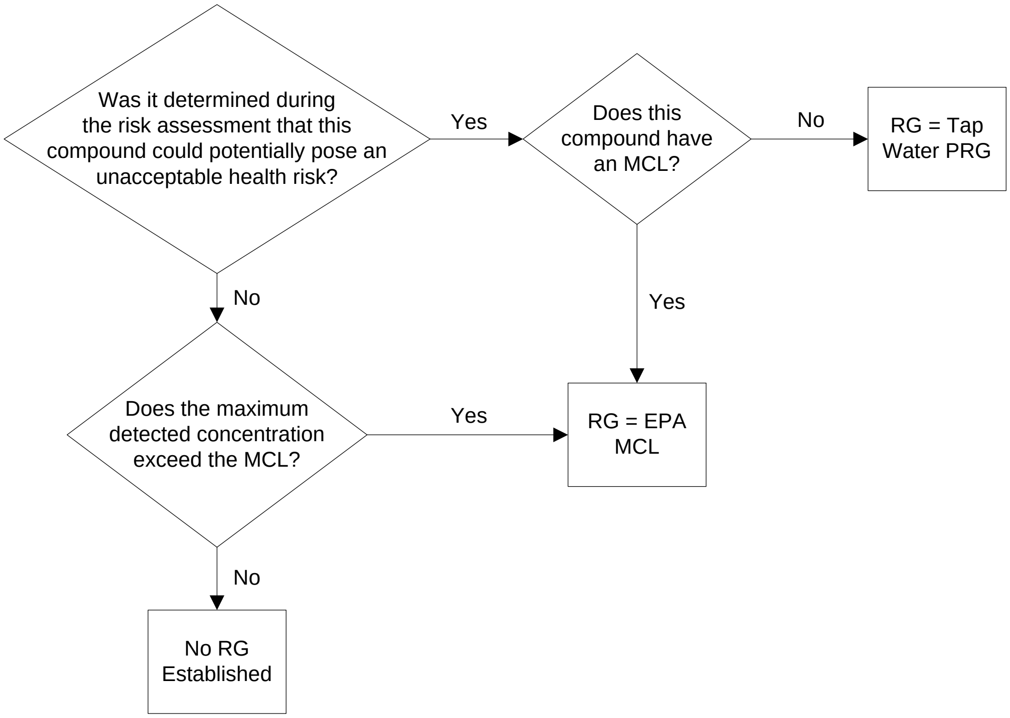
Feasibility Study Report
July 2011
Former PSC Site, Rock Hill, South Carolina



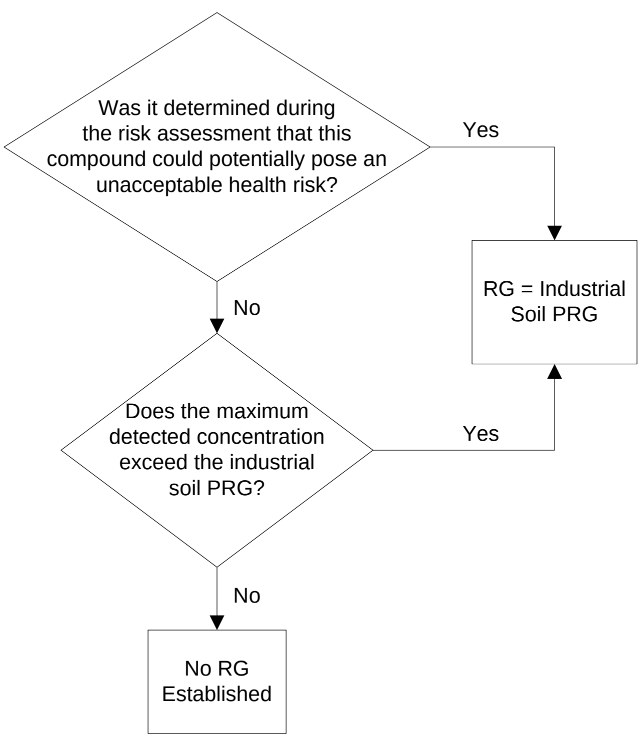
COPC = Chemical of Potential Concern
COC = Chemical of Concern
PRG = Preliminary Remediation Goal
MCL = EPA Maximum Contaminant Level
SSL = Soil Screening Level
DAF = Dilution Attenuation Factor
[1] The maximum concentration detected in uncovered areas was compared to an SSL with a DAF = 7 while the maximum concentration detected in covered areas was compared to an SSL with a DAF = 103.3.

Figure 2-5
Chemicals of Concern Development
Feasibility Study Report
Former PSC Site – Rock Hill, SC

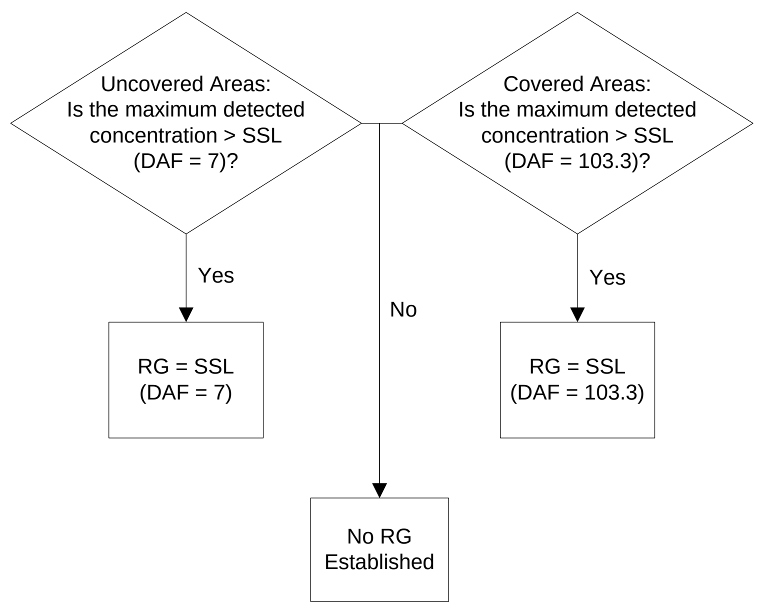
Groundwater



Metals in Soil

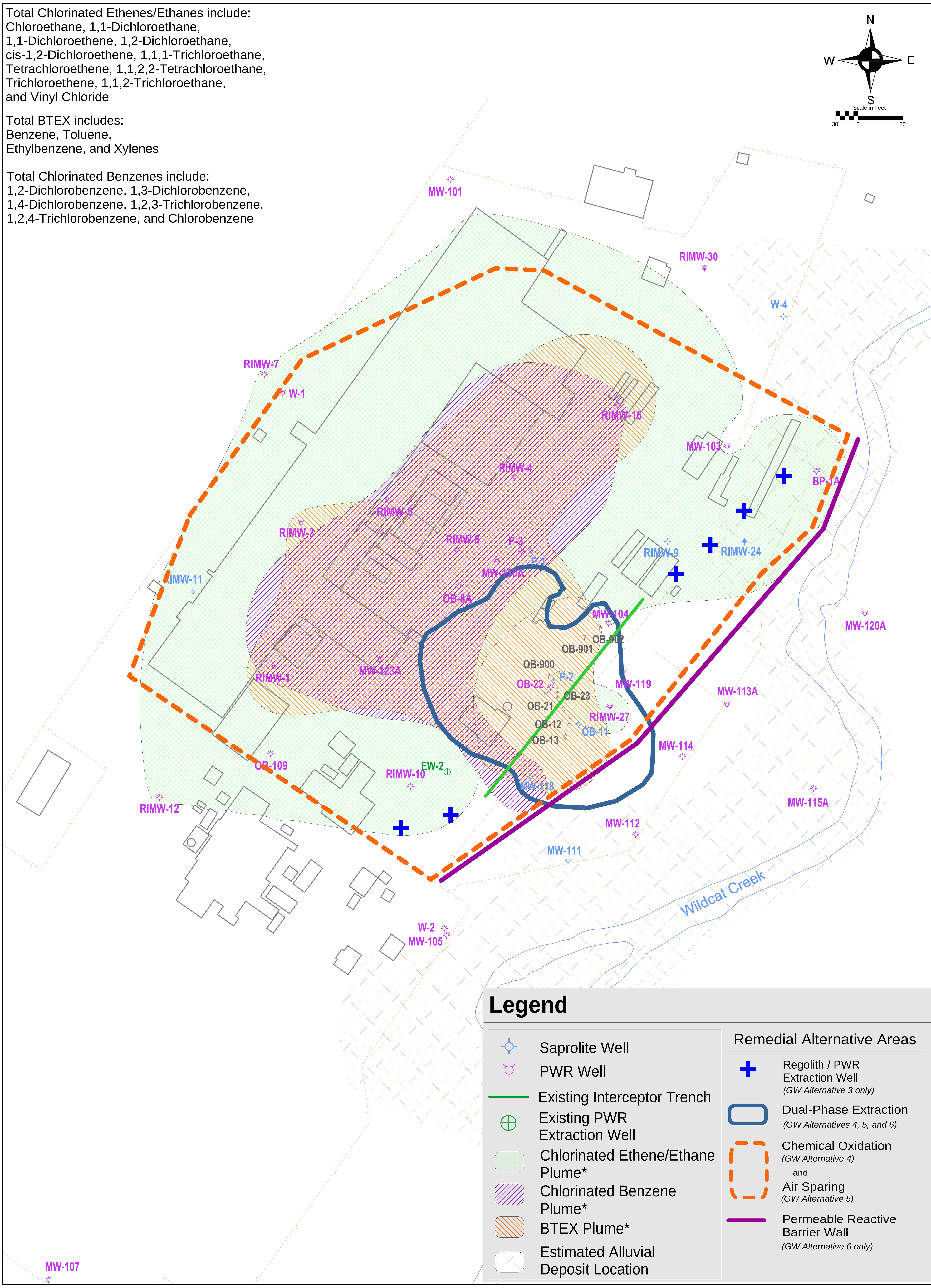


VOCs in Soil



VOC = Volatile Organic Compound
RG = Remediation Goal
PRG = Preliminary Remediation Goal
MCL = EPA Maximum Contaminant Level
SSL = Soil Screening Level
DAF = Dilution Attenuation Factor

Figure 3-1
Remedial Goals Development
Feasibility Study Report
Former PSC Site – Rock Hill, SC



*Plume - Areas with greater than 5 ug/L total Chlorinated Ethene/Ethanes, Chlorinated Benzenes, or BTEX

CDM

Figure 5-1
Regolith Groundwater Remedial Alternative Locations

Feasibility Study Report
Former PSC Site - Rock Hill, SC

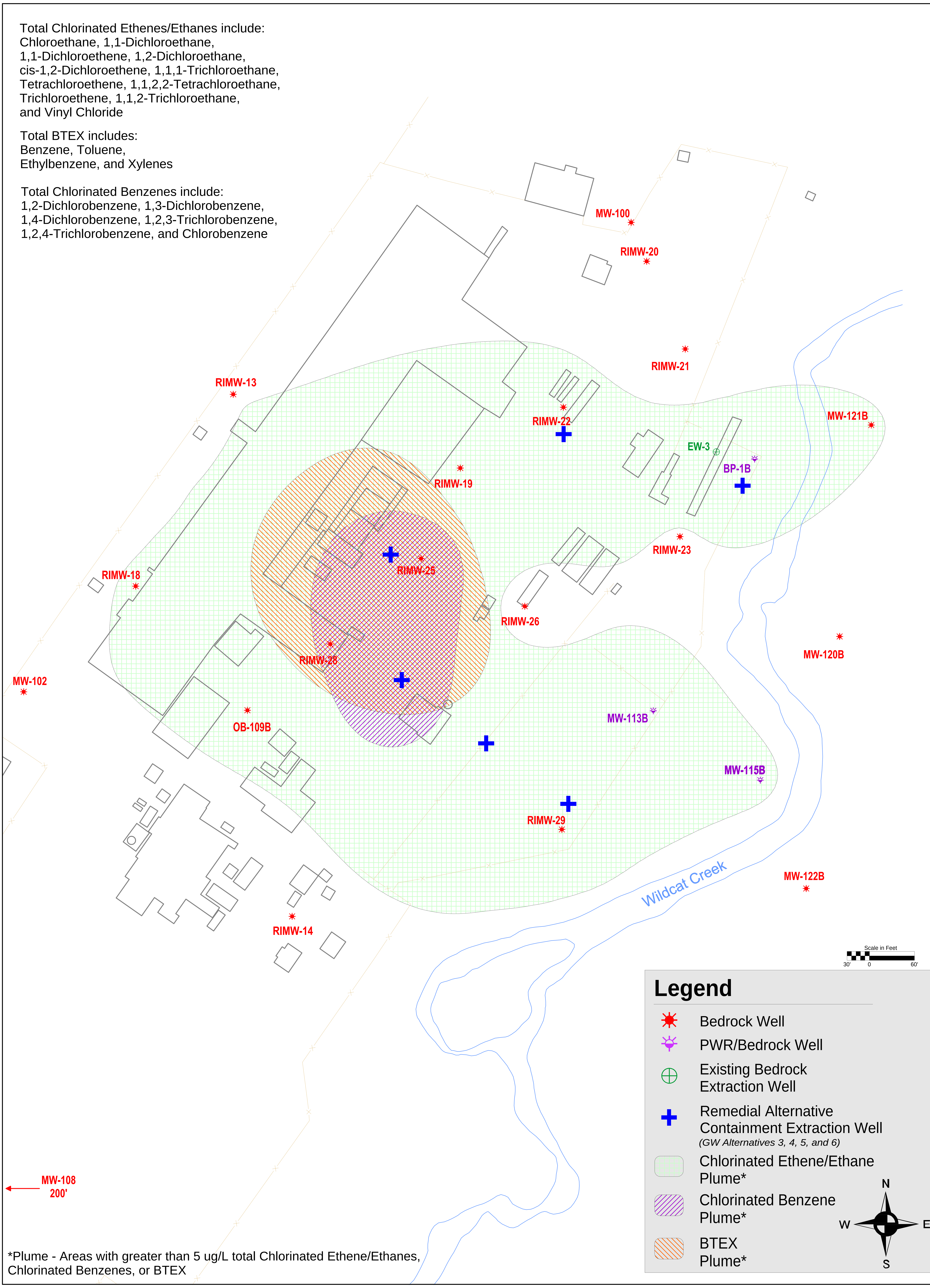
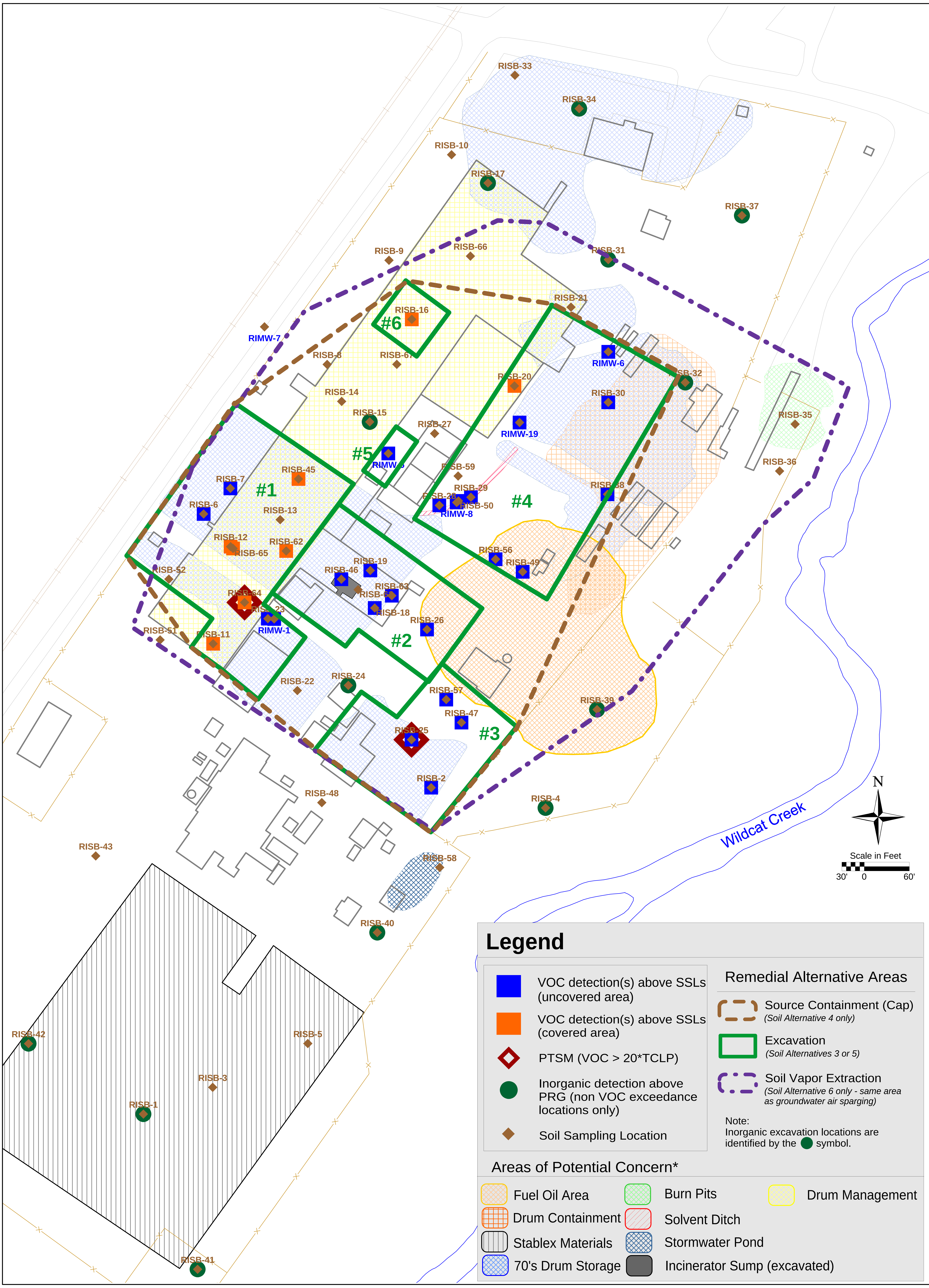


Figure 5-2
Bedrock Groundwater Remedial Alternative Locations

Feasibility Study Report
Former PSC Site - Rock Hill, SC

CDM

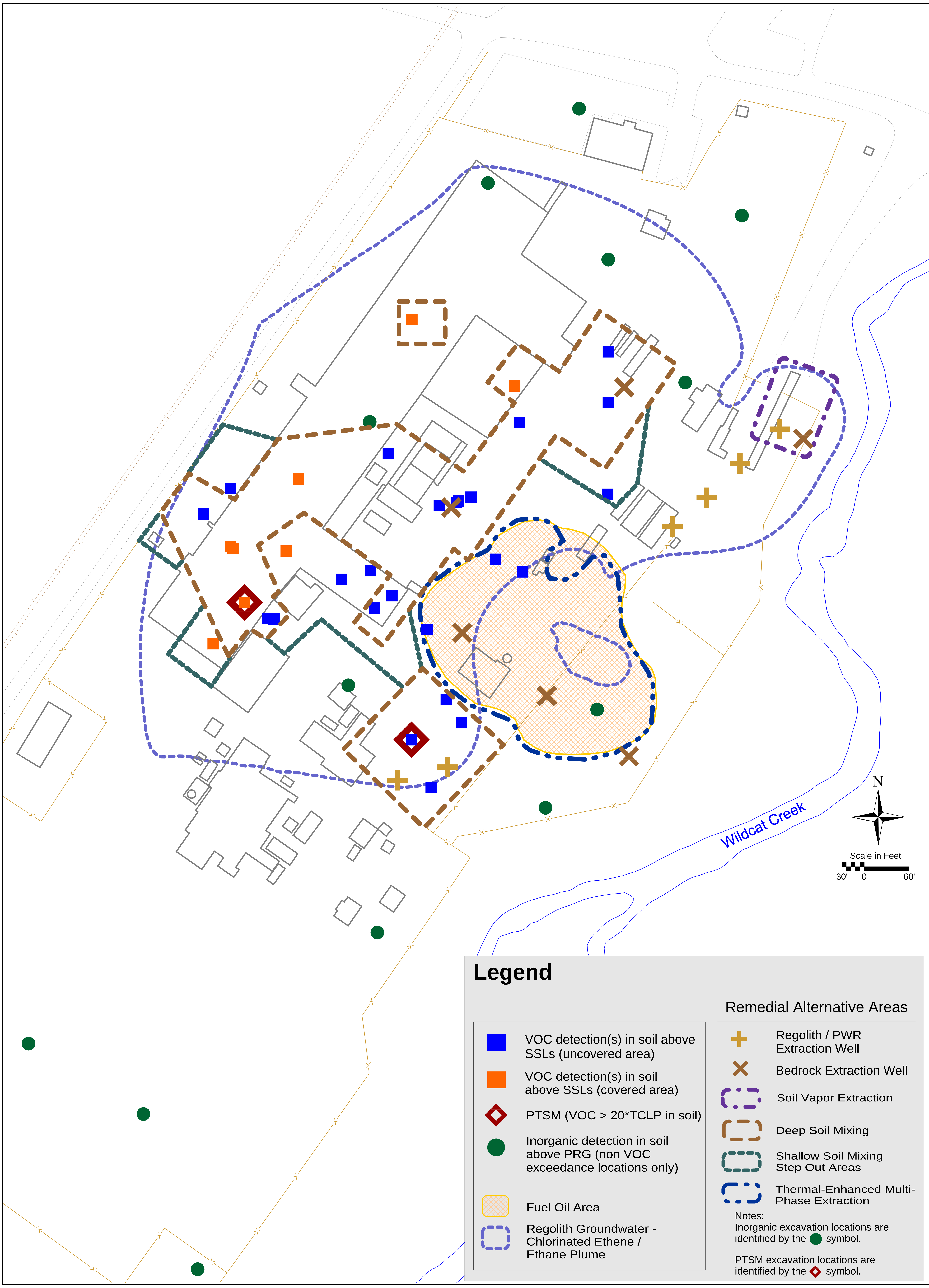


SSL - Soil Screening Level with Dilution-Attenuation Factor (DAF) of 7 in uncovered areas and DAF of 103.3 in covered areas.
PRG - Preliminary Remediation Goal for industrial soil.
PTSM - Principal Threat Source Material, defined as 20 * EPA toxicity criteria (i.e., TCLP).
*Areas of Potential Concern derived from "Environmental Data Review and Summary of Current Environmental Conditions," prepared by URS Corporation (March 2006)

Figure 5-3
Soil Remedial Alternative Locations

Feasibility Study Report
Former PSC Site - Rock Hill, SC

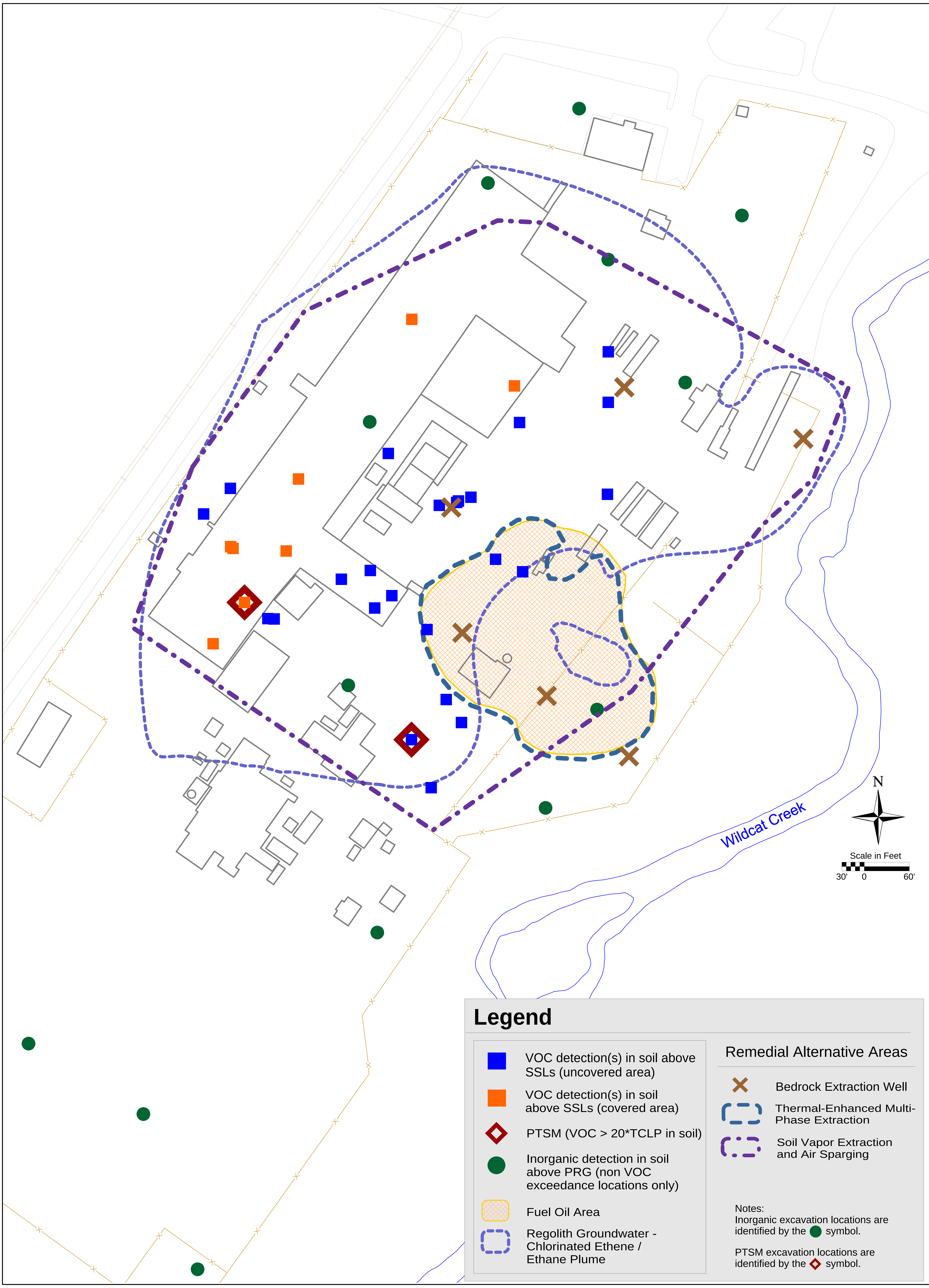
CDM



SSL - Soil Screening Level with Dilution-Attenuation Factor (DAF) of 7 in uncovered areas and DAF of 103.3 in covered areas.
PRG - Preliminary Remediation Goal for industrial soil.
PTSM - Principal Threat Source Material, defined as 20 * EPA toxicity criteria (i.e., TCLP).

Figure 5-4
Combination Alternative 1 Locations
Feasibility Study Report
Former PSC Site - Rock Hill, SC

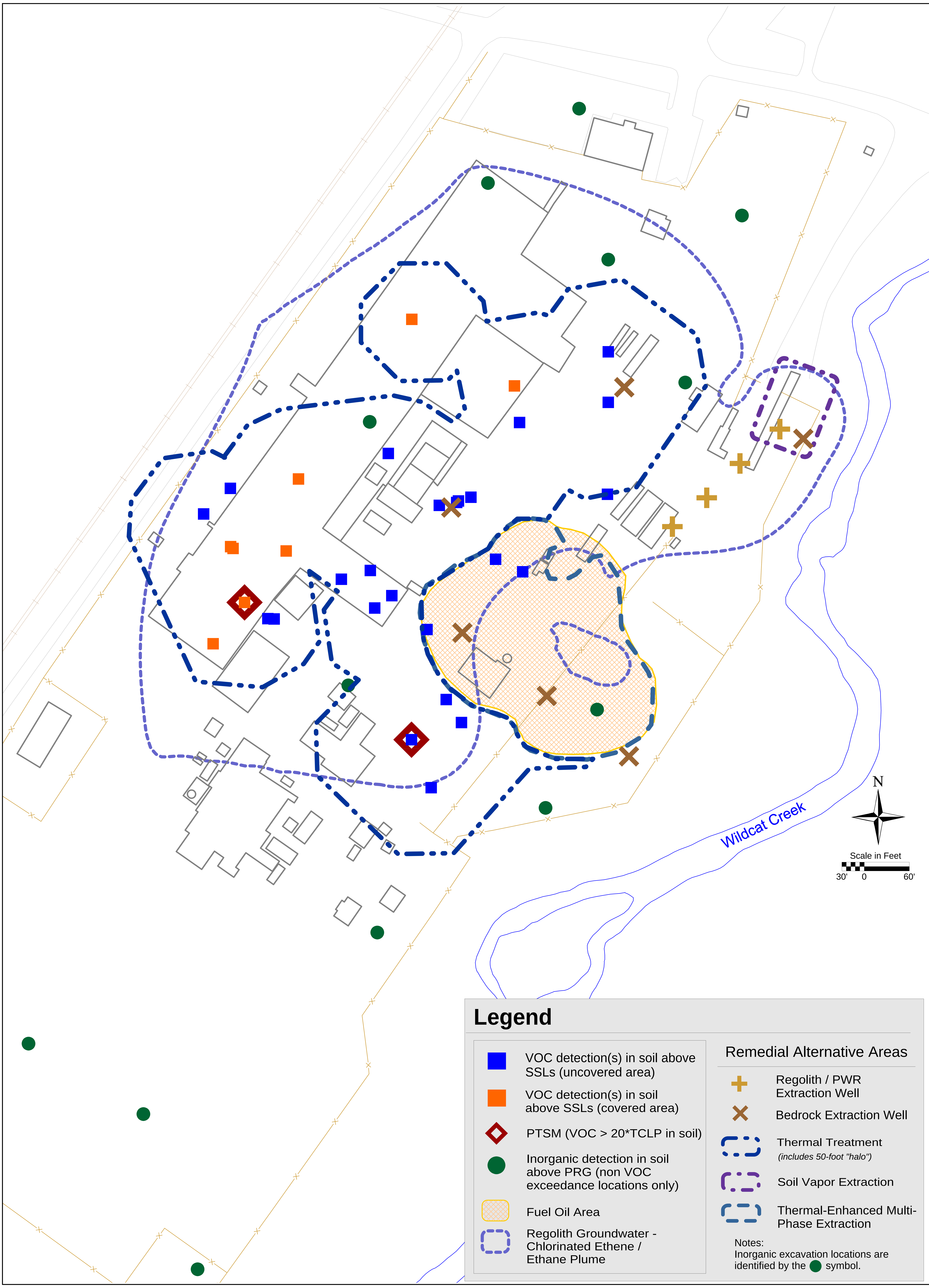
CDM



SSL - Soil Screening Level with Dilution-Attenuation Factor (DAF) of 7 in uncovered areas and DAF of 103.3 in covered areas.
PRG - Preliminary Remediation Goal for industrial soil.
PTSM - Principal Threat Source Material, defined as 20 * EPA toxicity criteria (i.e., TCLP).

Figure 5-5
Combination Alternative 2 Locations
Feasibility Study Report
Former PSC Site - Rock Hill, SC

CDM



SSL - Soil Screening Level with Dilution-Attenuation Factor (DAF) of 7 in uncovered areas and DAF of 103.3 in covered areas.
PRG - Preliminary Remediation Goal for industrial soil.
PTSM - Principal Threat Source Material, defined as 20 * EPA toxicity criteria (i.e., TCLP).

Figure 5-6
Combination Alternative 3 Locations
Feasibility Study Report
Former PSC Site - Rock Hill, SC

CDM

Tables

Table 2-1
Risk and Hazard Evaluation
Feasilibity Study Report
Former PSC Site - Rock Hill, SC

	Exceeds Acceptable Cancer Risk Range?[1]	Exceeds Noncancer HI Threshold?[2]
CURRENT EXPOSURE TO CHEMICALS SURFACE SOIL (EXCLUDING HOT SPOT AREAS AND BENEATH STRUCTURES) AND GROUNDWATER		
O&M Worker	No	No
Trespasser	**Yes**	No
CURRENT EXPOSURE TO CHEMICALS IN HOT SPOT AREA 1 SURFACE SOIL AND GROUNDWATER		
O&M Worker	**Yes**	No
FUTURE EXPOSURE TO CHEMICALS IN HOT SPOT AREA 1 SURFACE SOIL AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Resident	**Yes**	**Yes**
CURRENT/FUTURE EXPOSURE TO CHEMICALS IN HOT SPOT AREA 1 SURFACE SOIL AND GROUNDWATER		
Trespasser / Recreational	**Yes**	**Yes**
CURRENT EXPOSURE TO CHEMICALS IN HOT SPOT AREA 2 SURFACE SOIL AND GROUNDWATER		
O&M Worker	**Yes**	No
FUTURE EXPOSURE TO CHEMICALS IN HOT SPOT AREA 2 SURFACE SOIL AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Resident	**Yes**	**Yes**
CURRENT/FUTURE EXPOSURE TO CHEMICALS IN HOT SPOT AREA 2 SURFACE SOIL AND GROUNDWATER		
Trespasser / Recreational	No	No
FUTURE EXPOSURE TO CHEMICALS IN HOT SPOT AREA 3 SURFACE SOIL AND GROUNDWATER		
Trespasser / Recreational	**Yes**	**Yes**
Industrial Worker	**Yes**	**Yes**
Resident	**Yes**	**Yes**
FUTURE EXPOSURE TO CHEMICALS IN SURFACE SOIL (EXCLUDING HOT SPOT AREAS) AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Trespasser / Recreational	**Yes**	No
Resident	**Yes**	**Yes**
FUTURE EXPOSURE TO CHEMICALS IN SUBSURFACE SOIL (EXCLUDING HOT SPOT AREAS) AND GROUNDWATER		
Excavation Worker	No	**Yes**
Industrial Worker	**Yes**	**Yes**
Resident	**Yes**	**Yes**
FUTURE EXPOSURE TO CHEMICALS IN RIMW-6 AREA SUBSURFACE SOIL AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Excavation Worker	No	No
Resident	**Yes**	**Yes**
FUTURE EXPOSURE TO CHEMICALS IN RISB-12 AREA SUBSURFACE SOIL AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Excavation Worker	No	**Yes**
Resident	**Yes**	**Yes**
FUTURE EXPOSURE TO CHEMICALS IN RISB-18 AREA SUBSURFACE SOIL AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Excavation Worker	No	No
Resident	**Yes**	**Yes**
FUTURE EXPOSURE TO CHEMICALS IN RISB-25 AREA SUBSURFACE SOIL AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Excavation Worker	**Yes**	**Yes**
Resident	**Yes**	**Yes**
FUTURE EXPOSURE TO CHEMICALS IN RISB-64 AREA SUBSURFACE SOIL AND GROUNDWATER		
Industrial Worker	**Yes**	**Yes**
Excavation Worker	**Yes**	**Yes**
Resident	**Yes**	**Yes**

1: EPA's target risk range is $1E^{-6}$ to $1E^{-4}$.
2: EPA's noncancer threshold is 1.
Hot Spot Area 1: Area including RISB-6, RISB-19, RISB-26 and RISB-46
Hot Spot Area 2: Area including RIMW-6
Hot Spot Area 3: Area including RISB-16

Table 2-2
Final Chemicals of Concern (COCs)
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Soil COCs	Selection Rationale
Metals	
Arsenic	Exceeds SSL
Barium	Exceeds SSL
Chromium	Exceeds SSL
Iron	Exceeds Non-Cancer HI of 1.0
Manganese	Exceeds Non-Cancer HI of 1.0
Nickel	Exceeds SSL
Selenium	Exceeds SSL
Thallium	Exceeds Non-Cancer HI of 1.0
Vanadium	Exceeds Non-Cancer HI of 1.0
SVOCs	
N-Nitrosodiphenylamine	Exceeds SSL
VOCs	
1,1,1-Trichloroethane	Exceeds SSL
1,1,2-Trichloroethane	Exceeds SSL
1,1-Dichloroethene	Exceeds SSL
1,2,4-Trichlorobenzene	Exceeds SSL
1,2-Dichlorobenzene	Exceeds SSL
1,2-Dichloroethane	Exceeds Cancer Risk Range
1,4-Dichlorobenzene	Exceeds SSL
Acetone	Exceeds SSL
Benzene	Exceeds SSL
Chlorobenzene	Exceeds SSL
Chloroform	Exceeds SSL
cis-1,2-Dichloroethene	Exceeds SSL
Ethylbenzene	Exceeds SSL
Methylene chloride	Exceeds SSL
Tetrachloroethene	Exceeds Cancer Risk Range
Toluene	Exceeds SSL
Trichloroethene	Exceeds Cancer Risk Range
Vinyl chloride	Exceeds SSL
Xylenes (Total)	Exceeds SSL

Groundwater COCs	Selection Rationale
Metals	
Manganese	Exceeds Non-Cancer HI of 1.0
VOCs	
1,1,1-Trichloroethane	Exceeds MCL
1,1,2-Trichloroethane	Exceeds MCL
1,1-Dichloroethene	Exceeds MCL
1,2,4-Trichlorobenzene	Exceeds MCL
1,2-Dichlorobenzene	Exceeds MCL
1,2-Dichloroethane	Exceeds Cancer Risk Range
1,4-Dichlorobenzene	Exceeds Cancer Risk Range
Benzene	Exceeds Cancer Risk Range
Bis(2-ethylhexyl)phthalate	Exceeds MCL
Carbon Tetrachloride	Exceeds MCL
Chlorobenzene	Exceeds MCL
Chloroethane	Exceeds Non-Cancer HI of 1.0
cis-1,2-Dichloroethene	Exceeds Cancer Risk Range
Ethylbenzene	Exceeds Non-Cancer HI of 1.0
Isopropylbenzene	Exceeds Non-Cancer HI of 1.0
Methylene chloride	Exceeds Cancer Risk Range
Tetrachloroethene	Exceeds Cancer Risk Range
Toluene	Exceeds Non-Cancer HI of 1.0
Trichloroethene	Exceeds Cancer Risk Range
Vinyl chloride	Exceeds Cancer Risk Range
Xylenes (Total)	Exceeds Non-Cancer HI of 1.0

Notes:
HI - Hazard Index
MCL - EPA Maximum Contaminant Level
SSL - EPA Region 9 Soil Screening Level (7 for uncovered, 103.3 for covered areas)
SVOCs - Semi-Volatile Organic Compounds
VOCs - Volatile Organic Compounds

Table 3-1
Potential Chemical-Specific ARARs
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Standard Requirement, Criteria, or Limitation	Citation	Description	ARAR/TBC	Rationale for implementation
Federal				
Clean Air Act	42 USC Section 7409			
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes air quality levels that protect public health.	Applicable	Treatment of contaminated media may result in release of contaminants into the air.
Safe Drinking Water Act	40 USC Section 300			
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health-based standards for public water systems. Maximum Contaminant Levels (MCLs) are legally enforceable federal drinking water standards.	Relevant & Appropriate	Institutional controls preventing potable water use at the site should preclude applicability; however, standards may still be relevant and appropriate.
Maximum Contaminant Level Goals (MCLGs)	Publication L. No. 99-399, 100 State. 642 (1986)	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects.	Relevant & Appropriate	MCLGs for organic and inorganic contaminants should not be applicable if institutional controls are implemented but they may still be relevant and appropriate.
National Secondary Drinking Water Standards	40 CFR 143	Establishes welfare-based standards for public water systems (secondary maximum contaminant levels).	Relevant & Appropriate	Secondary standards for organic and inorganic contaminants are not enforceable regulations but may be considered relevant and appropriate.
Resource Conservation and Recovery Act (RCRA) as Amended	42 USC 6901, 6905, 6912, 6924, 6925			
Identification and Listing of Hazardous Waste	40 CFR Parts 262-265 and Parts 124, 270, and 271	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265, 124, 270, and 271.	Applicable	Some of the site's COCs may be considered hazardous for disposal purposes.
RCRA Land Disposal Restrictions	40 CFR Part 268	Sets proper disposal protocols for contaminants found in soil or residues from any treatment process.	Applicable	Contamination in site soils, sediments, or other residues should be disposed of properly, so the regulation is applicable if remediation requires disposal of waste.

Table 3-1
Potential Chemical-Specific ARARs
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Standard Requirement, Criteria, or Limitation	Citation	Description	ARAR/TBC	Rationale for implementation
Clean Water Act	33 USC Section 1251-1376			
Ambient Water Quality Criteria (AWQC)	40 CFR Part 131	Sets criteria for surface water quality based on toxicity to aquatic organisms and human health.	Applicable	AWQC criteria for organic and inorganic contaminants are applicable to surface waters on site, unless superseded by South Carolina water quality criteria.
Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment Assoc. Biota: 1997 Revision	Publication ES/ER/TM-95/R4 Oak Ridge National Lab	Presents sediment concentration guidelines based on in-stream studies.	To Be Considered	Sediment contamination is not anticipated to be an issue at this site. However, Wildcat Creek is close to anticipated remediation areas and therefore sediment guidelines may need to be considered in the future.
Preliminary Remediation Goals and Soil Screening Levels	EPA Region 9	Establishes risk-based criteria for exposures to soil, air, and water and established soil screening levels for protection of groundwater.	Applicable	In the absence of state standards, these criteria are applicable to site soils. PRGs are used for metals COCs in soil.
State				
South Carolina Safe Drinking Water Regulations	CR, Chap. 61, Reg. 58.5	Identifies specific contaminants and establishes the maximum concentration of the contaminants that are allowed in drinking water served to the public.	Applicable	Applicable to waters at the site.
South Carolina Water Classification Standards	CR, Chap. 61, Reg. 68	Establishes specific numeric water quality standards for protecting classified and existing water uses.	Applicable	These standards are relevant and appropriate because of connection between groundwater and surface water.
South Carolina Ambient Air Quality Standards	Dept. of Health and Environmental Control; Regulation 61-62.5	Standards for the quality of ambient air at or beyond a property line on which a source of pollution is emitting.	Relevant & Appropriate	May be relevant and appropriate if onsite treatment units are part of remedial action.

Table 3-2
Potential Action-Specific ARARs
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Standard Requirement, Criteria, or Limitation	Citation	Description	ARAR/TBC	Rationale for implementation
<u>Federal</u> *<u>Clean Air Act (CAA)</u>*				
Air Quality Particulate Non-Degradation Policy	40 CFR 50 NAAQS	Establishes specific standards for total suspended particulates and prohibits degradation in any area where air quality is better or equal to the standards in OAC 3745-17-02.	Relevant & Appropriate	This citation is relevant for any remedial action involving treatment or construction that might result in the release of total suspended particulates that might contribute to deterioration of air quality.
National Emissions Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR 61	Emissions standard for hazardous air pollutants for which no ambient air quality standard exists.	Relevant & Appropriate	May be relevant or appropriate if groundwater recovery and/or onsite treatment units are part of remedial actions.
<u>Resource Conservation and Recovery Act (RCRA) as amended</u>				
Hazardous Waste Determinations and Generators for Offsite TSD	40 CFR Part 262	Requirements for any generator who treats, stores, or disposes of hazardous wastes to determine whether or not the waste is hazardous.	Relevant & Appropriate	The procedures are established to determine whether wastes are subject to the requirements of RCRA. This citation is relevant if any soils, sediments, or other residue require characterization and removal for treatment, storage, or disposal (TSD).
Generators Who Transport Hazardous Waste for Offsite Treatment, Storage, or Disposal	40 CFR Part 262	Any generator of hazardous waste must use manifest system.	Relevant & Appropriate	This citation is relevant for any soils, sediments, and waters determined to be RCRA hazardous waste subject to the manifest requirements.
Land Disposal Restrictions	40 CFR 268	Provides for proper disposal of regulated contaminants found in soils and sediments.	Applicable	Potentially applicable if remedial actions call for the removal of contaminated sediment or soil for disposal.
Standards Applicable to Transport of Hazardous Waste	40 CFR Part 263	Establishes standards that apply to persons transporting hazardous waste with the U.S. if the transportation requires a manifest under 40 CFR 262.	Applicable	Potentially applicable if remedial actions call for offsite treatment and/or disposal of waste.

Table 3-2
Potential Action-Specific ARARs
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Standard Requirement, Criteria, or Limitation	Citation	Description	ARAR/TBC	Rationale for implementation
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and thereby constitute prohibited open dumps.	Relevant & appropriate	Potentially applicable if remedial actions call for offsite treatment and/or disposal of waste.
RCRA Waste Management Program	40 CFR 264	Requires owner/operator to control wind dispersal of particulate matter and provides technical criteria for hazardous waste treatment, storage, and disposal (TSD). Citation also specifies closure performance standard.	Relevant & Appropriate	Some remedial actions will require conformance with RCRA closure performance standard. The control of fugitive dust is potentially relevant to this site. If the contamination is deemed a RCRA waste, then these requirements are also relevant.
RCRA Releases from Solid Waste Management Units	40 CFR Part 264 Subpart F	Establishes groundwater protection standards, monitoring requirements, and technical requirements.	Relevant & Appropriate	onsite disposal might cause migration into the underlying aquifer, and potentially contaminate the groundwater systems.
		Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Relevant & Appropriate	Some remedial actions will require conformance with RCRA closure performance standard. If the contamination is deemed a RCRA waste, then these requirements are also relevant.
Discharge of Storm Water Runoff	40 CFR 122.26	Requires storm water management.	Relevant & Appropriate	Required of all industrial and construction sites of greater than 1 acre that discharge storm water runoff to the waters of the United States.
NPDES	40 CFR 122	General permits for discharge from construction.	Relevant & Appropriate	Relevant to discharge of treated groundwater or surface water.

Table 3-2
Potential Action-Specific ARARs
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Standard Requirement, Criteria, or Limitation	Citation	Description	ARAR/TBC	Rationale for implementation
Occupational Safety and Health Administration (OSHA)				
Hazardous Waste Site Operations	29 CFR 1910	Provides safety rules for handling specific chemicals for site workers during remedial activities.	Relevant & Appropriate	Health and safety requirements are appropriate to all potential remedial actions.
State				
South Carolina Safe Drinking Water Regulations	CR, Chap. 61, Regulation 60	Establishes MCLs for the protection of human health.	Relevant & Appropriate	Relevant with discharge to surface water or POTW.
South Carolina Water Classification Standards	CR, Chap. 61, Reg. 68	Establishes surface water quality standards for the protection of the environment.	Relevant & Appropriate	Relevant if remedial action includes discharge of treated water.
South Carolina Hazardous Waste Management Regulations	CR, Chap. 61, Reg. 79	Establishes requirements for hazardous waste treatment, storage, and disposal (TSD) facilities	Applicable	Applicable if remedial action includes onsite treatment or storage of hazardous wastes.
South Carolina Hazardous Waste Management Location Standards	CR, Chap. 61, Reg. 104	Establishes requirements for the location of hazardous waste treatment, storage, and disposal (TSD) facilities	Applicable	Relevant if remedial action includes onsite treatment or storage of hazardous wastes.
South Carolina Solid Waste Management Regulations	CR, Chap. 61, Reg. 107	Specifies the performance standards that must be met by disposal facilities.	Applicable	Applicable if remedial action includes onsite treatment, storage, disposal, or transport of solid wastes.
South Carolina Air Pollution Control Regulations	Dept. of Health & Environmental Control, Regulation 61-62	Air pollution control by established air quality and emission standards.	Relevant & Appropriate	Applicable if selected remedial alternative produces air emissions.
South Carolina NPDES Permit Regulations	CR, Title 61, Cap. 9	Requires permit for discharge of wastes into waters of the state.	Relevant & Appropriate	Relevant if remedial action includes discharge of treated water.
South Carolina Underground Injection Control Regulations	CR, Chap. 61, Reg. 87	Requirements for controlling underground injection in the state.	Relevant & Appropriate	Relevant if remediation involves underground injection of contaminated media or chemical additive.

Table 3-3
Potential Location-Specific ARARs
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Standard Requirement, Criteria, or Limitation	Citation	Description	ARAR/TBC	Rationale for implementation
Federal				
Clean Water Act	33 USC Section 1251-1376			
Dredge or Fill Requirements (Section 404)	40 CFR Part 230	Requires Permit for discharge of dredge or fill material into aquatic environments.	To Be Considered	May be applicable at the site if remedies involve work in Wildcat Creek.
Endangered Species Act	16 USC Section 1531; 40 CFR Part 6.302; 50 CFR Part 402	Requires action to conserve endangered species within critical habitat upon which species depend; includes consultation with the Department of the Interior.	Relevant & Appropriate	No threatened or endangered species are known to occur on site, but some have the potential to occur in the general area of the site.
Migratory Bird Treaty of 1973	16 USC Section 703	Established a prohibition, unless permitted, to pursue, hunt, capture, kill, or take any migratory bird or attempt any of these actions. Also protects migratory birds in their environments.	Relevant & Appropriate	Potential remedial alternatives may adversely affect migratory birds.
U.S. Fish and Wildlife Service Mitigation Policy	FR Vol 46 (15): 7656-7663	Provides for the policy to develop consistent and effective recommendations to protect and conserve natural resources. Also allows federal and private developers to incorporate mitigation measures.	Applicable	Many species of plants and animals occur on site or are expected to occur on site.
Groundwater Classification	EPA Groundwater Protection Strategy	Through process of classification, groundwater resources are separated into categories on the basis of their value to society, use, and vulnerability to contamination. Groundwater classes factor into deciding the level of protection or remediation the resource will be provided.	To Be Considered	Contaminants are present in groundwater.

Table 3-3
Potential Location-Specific ARARs
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Standard Requirement, Criteria, or Limitation	Citation	Description	ARAR/TBC	Rationale for implementation
Resource Conservation and Recovery Act (RCRA) Releases from Solid Waste Management Units	42 USC 6901, 6905, 6912, 6924, 6925			
RCRA Location Standards	40 CFR Part 264.18(b)	A TSD facility must be designed, constructed operated and maintained to avoid washout on a 100-year floodplain. Also, a TSD facility must not be located within 200 feet from a fault line.	Applicable	Potential remedial alternatives may be implemented within the 100-year floodplain.
Protection of Wetlands and Floodplains	40 CFR Part 6, Appendix A	Contains EPA's regulations for implementing Executive Orders 11988 and 11990.	Applicable	Site is near Lower Catawba River floodplain.
Floodplain Management Executive Order	Executive Order 11988	Action to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of the floodplain.	Applicable	Site is near Lower Catawba River floodplain.
State				
South Carolina Hazardous Waste Facility Siting Standards	CR, Chap. 61, Reg. 104	Creates requirements for the location of hazardous waste TSD facilities. Such facilities will be limited to those areas where there will be minimal impact on human health and the environment.	Relevant & Appropriate	May be relevant and appropriate if onsite treatment units are used for remediation of contaminated media.

Table 3-4
Groundwater Remedial Goals
Feasibility Study
Former PSC Site - Rock Hill, SC

Compound	Remedial Goal (ug/L)	Source	Basis for Establishing an RG
1,1,1-Trichloroethane	200	MCL	Exceeds MCL
1,1,2-Trichloroethane	5	MCL	Exceeds MCL
1,1-Dichloroethene	7	MCL	Exceeds MCL
1,2,4-Trichlorobenzene	70	MCL	Exceeds MCL
1,2-Dichlorobenzene	600	MCL	Exceeds MCL
1,2-Dichloroethane	5	MCL	RA and Exceeds MCL
1,4-Dichlorobenzene	75	MCL	RA and Exceeds MCL
Benzene	5	MCL	RA and Exceeds MCL
Bis(2-ethylhexyl)phthalate	6	MCL	Exceeds MCL
Carbon tetrachloride	5	MCL	Exceeds MCL
Chlorobenzene	100	MCL	Exceeds MCL
Chloroethane	4.6	PRG	RA
cis-1,2-Dichloroethene	70	MCL	RA and Exceeds MCL
Ethylbenzene	700	MCL	RA and Exceeds MCL
Methylene chloride	5	MCL	RA and Exceeds MCL
Tetrachloroethene	5	MCL	RA and Exceeds MCL
Toluene	1000	MCL	RA and Exceeds MCL
Trichloroethene	5	MCL	RA and Exceeds MCL
Vinyl chloride	2	MCL	RA and Exceeds MCL
Xylenes (Total)	10000	MCL	RA and Exceeds MCL

Notes:

MCL - U.S. Environmental Protection Agency Maximum Contaminant Level (June 2003)

PRG - EPA Region 9 Preliminary Remediation Goal for tap water (October 2004)

RA - Indicates that this compound was detected at levels that result in a risk assessment calculation above established non-cancer or cancer risk ranges.

Isopropylbenzene was identified as posing a non-cancer human health risk during the risk assessment. However, this compound was not included on this table because neither an MCL or PRG is established for this compound.

Table 3-5
Soil Remedial Goals
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Compound	*Protection of Groundwater*						*Protection of Human Health*		
	Uncovered Areas			Areas Under Buildings / Slabs					
	Remedial Goal (mg/kg)	Source	Basis for Establishing an RG	Remedial Goal (mg/kg)	Source	Basis for Establishing an RG	Remedial Goal (mg/kg)	Source	Basis for Establishing an RG
1,1,1-Trichloroethane	0.70	SSL1	Exceeds SSL1						
1,1,2-Trichloroethane	0.006	SSL1	Exceeds SSL1	0.093	SSL2	Exceeds SSL2			
1,1-Dichloroethene	0.021	SSL1	Exceeds SSL1	0.31	SSL2	Exceeds SSL2			
1,2,4-Trichlorobenzene	2.1	SSL1	Exceeds SSL1						
1,2-Dichlorobenzene	6.3	SSL1	Exceeds SSL1						
1,2-Dichloroethane	0.007	SSL1	Exceeds SSL1	0.10	SSL2	Exceeds SSL2	0.6	PRG	RA and Exceeds PRG
1,4-Dichlorobenzene	0.70	SSL1	Exceeds SSL1						
Acetone	5.6	SSL1	Exceeds SSL1						
Arsenic							1.6	PRG	Exceeds PRG
Benzene	0.014	SSL1	Exceeds SSL1	0.21	SSL2	Exceeds SSL2	1.4	PRG	Exceeds PRG
Chlorobenzene	0.49	SSL1	Exceeds SSL1						
Chloroform	0.21	SSL1	Exceeds SSL1				0.47	PRG	Exceeds PRG
cis-1,2-Dichloroethene	0.140	SSL1	Exceeds SSL1	2.1	SSL2	Exceeds SSL2			
Ethylbenzene	4.9	SSL1	Exceeds SSL1	72.3	SSL2	Exceeds SSL2			
Iron							100,000	PRG	RA
Manganese							19,458	PRG	RA
Methylene chloride	0.007	SSL1	Exceeds SSL1	0.10	SSL2	Exceeds SSL2			
N-Nitrosodiphenylamine	0.42	SSL1	Exceeds SSL1						
Tetrachloroethene	0.021	SSL1	Exceeds SSL1	0.31	SSL2	Exceeds SSL2	1.3	PRG	RA and Exceeds PRG
Thallium							67.5	PRG	RA and Exceeds PRG
Toluene	4.2	SSL1	Exceeds SSL1	62.0	SSL2	Exceeds SSL2	520	PRG	Exceeds PRG
Trichloroethene	0.021	SSL1	Exceeds SSL1	0.31	SSL2	Exceeds SSL2	0.11	PRG	RA and Exceeds PRG
Vanadium							1,022	PRG	RA
Vinyl chloride	0.005	SSL1	Exceeds SSL1	0.072	SSL2	Exceeds SSL2			
Xylenes (Total)	70	SSL1	Exceeds SSL1				420	PRG	Exceeds PRG

Notes:

SSL1 - EPA Region 9 Soil Screening Level (October 2004) with a Dilution Attenuation Factor of 7 (see below)

SSL2 - EPA Region 9 Soil Screening Level (October 2004) with a Dilution Attenuation Factor of 103.3 (see below)

PRG - EPA Region 9 Preliminary Remediation Goal for Industrial Soil (October 2004)

RA - Indicates that this compound was detected at levels that result in a risk assessment calculation above established non-cancer or cancer risk ranges.

RGs apply to both surface and subsurface soil.

Dilution Attenuation Factors for uncovered areas and areas under building slabs were calculated by the South Carolina Department of Health and Environmental Control using site-specific assumptions. For determination of SSL exceedances, soil data were first segregated by the samples that were under building slabs and those that were not (e.g., exceedances of SSL2 for areas under buildings only incorporates soil data from samples collected under building slabs). Exceedances for industrial soil PRGs includes all soil areas.

Protection of Groundwater RG = [SSL with DAF of 1] * [Site-Specific DAF]

Table 4-1
Initial Screening of Technologies and Process Options for Groundwater
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
No Action	None	Not Applicable	Site is left in its existing state.	Required for consideration by the NCP.
Institutional Controls	Access and Use Restrictions	Land Use and Deed Restrictions	Land use restrictions recorded in property deeds to prohibit groundwater or surface water use in impacted areas.	Retained for further evaluation.
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater	Site conditions and contaminant levels in these media would be monitored during and after implementation of remedial action.	Retained for further evaluation.
Containment / Removal	Subsurface Barriers	All Processes	Use of grouts, low permeability slurry, or liners placed perpendicular to groundwater flow to form an impermeable barrier (vertical barrier).	Retained for further evaluation.
	Extraction Wells	All Processes	Series of wells installed to collect or extract contaminated groundwater.	Retained for further evaluation.
	Well Points	All Processes	A group of closely-spaced wells within a contaminated area is connected to a header pipe and pumped by a suction pump.	Retained for further evaluation.
	Subsurface Drains	All Processes	Perforated pipe or tile with a gravel-filled trench is used to remove or redirect contaminated groundwater.	Retained for further evaluation.
	Phytoremediation	All Processes	Phytoremediation is a set of processes that use plants to assist with hydraulic containment and/or provide groundwater treatment	Retained for further evaluation.
Treatment	In Situ	Air Sparging	System of wells to inject air into the aquifer to strip volatile organics from groundwater.	Retained for further evaluation.
		Enhanced Bioremediation	Optimization of environmental conditions by injecting oxygen, nutrients, and (if necessary) microorganisms into the subsurface to enhance microbial degradation of contaminants.	Retained for further evaluation.
		Monitored Natural Attenuation	Natural subsurface processes—such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface that reduce concentrations and/or mobility of contaminants.	Retained for further evaluation.
		Phytoremediation	Phytoremediation is a set of processes that use plants to clean contamination in soil, groundwater, surface water, sediment, and air. Phytoremediation is limited to shallow groundwater.	Rejected. Depth to water is too great.
		Chemical Oxidation	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	Retained for further evaluation.
		Dual Phase Extraction (DPE)	A high vacuum system is applied to simultaneously remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface.	Retained for further evaluation.
		Enhanced DPE	Dual phase extraction used in combination with injection of air or chemical to enhance vapor recovery of free phase LNAPL or high concentrations of dissolved VOCs.	Retained for further evaluation.
		Passive/Reactive Treatment Walls	Trenches or walls are filled with a permeable medium that reacts with or traps contaminants as contaminated groundwater flows through the trench/wall.	Retained for further evaluation.
		Thermal	Steam/hot air injection or electromagnetic/fiber optic/radio frequency/electrical conduction heating is used to increase the mobility of volatiles and facilitate extraction. The process includes a system for handling off-gases.	Retained for further evaluation.
		In-Well Air Stripping	Air is injected into a double screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, some of the VOCs in the contaminated groundwater are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.	Retained for further evaluation.
	Ex Situ — **Thermal**	**Evaporation**	Contaminated waste stream is placed in large drying beds. Its volume is then reduced or eliminated through vaporization caused by solar heating.	Rejected. Ex-situ groundwater treatment system already being used on site.

(Shaded dashed box) Technology / process option eliminated from further consideration.

Table 4-1
Initial Screening of Technologies and Process Options for Groundwater
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
Treatment — Ex Situ	Thermal	Wet Air Oxidation	Oxidation of organics in an aerator under high temperature and pressure.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Incineration	High temperatures, 1,600 to 2,200 degrees F, are used to volatilize and combust (in the presence of oxygen) organic contaminants in hazardous waste. Processes include liquid injection, rotary-kiln, fluidized- and circulatory-bed, and infrared.	Rejected. Ex-situ groundwater treatment system already being used on site.
	Biological	Biological Sorption	An innovative process being developed under the SITE Emerging Technologies Program. The process is based on the affinity of algae cell walls for heavy metal ions, and is being tested for the removal of metal ions containing high levels of dissolved solids from groundwater or surface leachate.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Wetland-Based Treatment	An innovative approach that uses natural biological and geochemical processes inherent in man-made wetlands to accumulate and remove metals from contaminated water. Process incorporates ecosystem components from wetlands to remove metals by filtration, ion exchange, adsorption, absorption and precipitation through geochemical and microbial oxidation and reduction.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Biological Treatment	Aerated process consists of microbial degradation of wastes in an aerated surface impoundment (oxidation pond), lagoon, or biological digester. Anaerobic process consists of a low surface area to volume ratio (narrow to deep) used to increase degradation action by anaerobic bacteria.	Rejected. Ex-situ groundwater treatment system already being used on site.
	Off Site	Wastewater Treatment Facility	Extracted groundwater or surface water transported to a treatment, storage, and disposal facility for treatment.	Rejected. Ex-situ groundwater treatment system already being used on site.
	Physical / Chemical	Air Stripping	Mixing of large volumes of air with waste stream in a packed column or through diffused aeration to transfer volatile organics to air.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Carbon Adsorption	Adsorption of contaminants onto activated carbon by passing water through carbon column.	Retained. Current system uses carbon adsorption.
		Centrifugation	Stable colloidal particles are removed by the centrifugal forces created by high speed rotation in a cylindrical vessel.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Dehalogenation	Chemical agent is mixed with waste stream to strip halogen atoms from chlorinated hydrocarbons.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Evaporation & Distillation	Volatile organics are separated at optimum temperature and pressure using evaporation followed by condensation.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Filtration	Removal of suspended particles by passing the liquid waste stream through a granular or fabric media.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Ion Exchange	Contaminated water is passed through a resin bed where ions are exchanged between resin and water.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Liquid-Liquid Extraction	Two liquids are separated by the addition of a third liquid that is a solvent for one of the liquids and is insoluble for the other	Rejected. Ex-situ groundwater treatment system already being used on site.
		pH Adjustment	A chemical reagent is added to the waste stream to alter the pH.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Oil-Water Separation	A gravity-based process used to separate two immiscible liquids, such as petroleum and water.	Retained. Current system uses oil-water separator.
		Precipitation / Coagulation / Flocculation	A chemical agent is mixed with the waste stream to form an insoluble product that can be removed from the waste stream by settling. Usually in conjunction with coagulation and flocculation and as a pretreatment step before organics treatment where the process could be easily fouled by inorganics.	Rejected. Ex-situ groundwater treatment system already being used on site.

[shaded dashed box] Technology / process option eliminated from further consideration.

Table 4-1
Initial Screening of Technologies and Process Options for Groundwater
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
Treatment — Ex Situ	Physical / Chemical	**Aeration**	Aeration can be used to induce chemical precipitation of certain inorganic contaminants or strip volatile constituents.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Adsorption	Process is similar to carbon adsorption with a resin or other material replacing the carbon as the absorbent.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Sedimentation	Suspended solids removed from liquid by gravity in a tank or lagoon. Often preceded by precipitation.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Steam Stripping	Mixing of large volumes of steam with the waste stream in a packed column or through diffused aeration to transfer volatile organics to the air.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Ultrafiltration	Removal of medium to high molecular weight solutes from solution by a semipermeable membrane under a low pressure gradient.	Rejected. Ex-situ groundwater treatment system already being used on site.
Discharge	On Site	**Surface Water**	Discharge of treated water to a surface water body.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Injection Wells	Discharge of treated water by injection through on site wells.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Spray Irrigation	Treated water discharged through plant uptake, evaporation and percolation through soil.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Infiltration	Treated water allowed to infiltrate into the aquifer through use of open pond or underground piping.	Rejected. Ex-situ groundwater treatment system already being used on site.
		Existing Industrial Wastewater Treatment Facility	Extracted groundwater discharged to existing industrial wastewater treatment plant.	Retained for further evaluation.
	Off Site	POTW	Extracted and/or treated groundwater discharged to local public-owned treatment works (POTW).	Retained for further evaluation.

(Shaded dashed box) Technology / process option eliminated from further consideration.

Table 4-2
Initial Screening of Technologies and Process Options for Soil
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
No Action	None	Not Applicable	Site is left in its existing state.	Required for consideration by the NCP.
Institutional Controls	Access and Use Restrictions	Land Use and Deed Restrictions	Land use restrictions recorded in property deeds to prohibit activities in impacted areas.	Retained for further evaluation.
		Fencing	Security fence installed around contaminated area to limit access.	Retained for further evaluation.
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater	Site conditions and contaminant levels in these media would be monitored during and after implementation of remedial action.	Retained for further evaluation.
Containment	Caps	All Processes	Placement of a cap of low permeability material over the landfill or source areas to minimize the infiltration of surface water. Cap types include native soil, clay, asphalt, concrete, synthetic membrane, and RCRA multilayer.	Retained for further evaluation.
	Subsurface Barriers	All Processes	Use of grouts, low permeability slurry, or liners placed perpendicular to wastes to form an impermeable groundwater barrier (vertical barrier).	Retained for further evaluation.
	Surface Diversion / Collection	All Processes	Can include changes to surface topography grade to promote drainage away from contamination source area, creation of dikes and berms for erosion/sedimentation control and creation of channels to convey stream flows away from source areas.	Retained for further evaluation.
Removal / Extraction	Excavation	All Processes	Use of mechanical excavating equipment to remove and load contaminated sediment or soil for transport.	Retained for further evaluation.
Treatment — In Situ	Biological	Biodegradation	The activity of naturally-occurring microbes is stimulated by circulating water-based solutions through contaminated soil to enhance in situ biological degradation of organic contaminants. Nutrients, oxygen, or other amendments may be used to enhance biodegradation and contaminant desorption from subsurface materials.	Retained for further evaluation.
		Bioventing	Bioventing is the process of aerating soils to stimulate in situ biological activity and promote bioremediation. Bioventing typically is applied in situ to the vadose zone (i.e., unsaturated soils) by injecting oxygen in the form of air. Bioventing systems are designed to maximize biodegradation while minimizing volatilization. Additives required for chlorinated VOC degradation.	Rejected. Not generally used for chlorinated VOCs.
		Phytoremediation	Contaminants are made unavailable to biological organisms after uptake through tree (e.g., poplar) roots.	Retained for further evaluation.
	Physical/Chemical	Chemical Reduction / Oxidation	Reduction/oxidation chemically converts hazardous contaminants to non hazardous or less toxic compounds that are more	Retained for further evaluation.
		Soil Mixing	Stabilized soil columns formed by a series of mixing shafts where oxidant, for example, is injected into soil by pumping through the hollow stems of the shafts as they are advanced into the soil.	Retained for further evaluation.
		Electrokinetic Separation	The Electrokinetic Remediation (ER) process removes metals and organic contaminants from low permeability soil, mud, sludge, and marine dredging. ER uses electrochemical and electrokinetic processes to desorb, and then remove, metals and polar organics. This in situ soil processing technology is primarily a separation and removal technique for extracting contaminants from soils.	Retained for further evaluation.
		Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Contaminants are leached into the groundwater, which is then extracted and captured/treated/removed.	Rejected. Vadose zone greater than 20 feet in many areas.
		Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure gradient that induces gas-phase volatiles to diffuse through soil to extraction wells. The process includes a system for handling off gases. This technology is known as in situ soil venting, in situ volatilization, enhanced volatilization, or soil vacuum extraction.	Retained for further evaluation.
		Solidification / Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Rejected. Not used for chlorinated VOCs.
	Thermal	Vitrification	Electrodes for applying electricity, or joule heating, are used to melt contaminated soil, producing a glass and crystalline structure with very low leaching characteristics.	Retained for further evaluation.
		Electrical Resistance Heating	Electrical resistance heating uses an electrical current to heat less permeable soils such as clays and fine-grained sediments so that water and contaminants trapped in these relatively conductive regions are vaporized and ready for vacuum extraction.	Retained for further evaluation.
		Thermal Conductive Heating	Supplies heat to the soil through steel wells or with a blanket that covers the ground surface. As the polluted area is heated, the contaminants are destroyed or evaporated. Also referred to as electrical conductive heating or in situ thermal desorption.	Retained for further evaluation.
		Steam Extraction	Steam/hot air injection is used to increase the mobility of volatiles and facilitate extraction. The process includes a system for handling off gases.	Retained for further evaluation.

(Shaded box) Technology / process option eliminated from further consideration.

Table 4-2
Initial Screening of Technologies and Process Options for Soil
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action		Remedial Technology	Process Option	Description	Screening Comment
Treatment	Ex Situ	Thermal	Incineration	High temperatures, 1,600 to 2,200 degrees F, are used to volatilize and combust (in the presence of oxygen) organic contaminants in hazardous waste. Processes include liquid injection, rotary-kiln, fluidized- and circulatory-bed, and infrared.	Retained for further evaluation.
			Thermal Desorption	Wastes are heated at low or medium temperatures to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.	Retained for further evaluation.
			Vitrification	Contaminated soil is melted at high temperatures to form glass and crystalline characteristics.	Retained for further evaluation.
		Biological	Solid Phase	Excavated sediment is mixed with amendments and placed in aboveground enclosures that have leachate collection systems and some form of aeration. Processes include prepared treatment beds, biotreatment cells, and soil piles. Moisture, heat, nutrients, oxygen, and pH may be controlled to enhance biodegradation.	Retained for further evaluation.
			Slurry Phase	An aqueous slurry is created by combining sediment with additional water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. Nutrients, oxygen, and pH in the bioreactor may be controlled to enhance biodegradation. Upon completion of the process, the slurry is dewatered and the treated soil is disposed.	Retained for further evaluation.
		Off Site	Waste Treatment Facility	Contaminated sediments are excavated and transported to an offsite facility for treatment and disposal.	Retained for further evaluation.
		Physical / Chemical	Dehalogenation	Reagents are added to soils contaminated with halogenated organics. The dehalogenation process is achieved by either the replacement of the halogen molecules or the decomposition and partial volatilization of the contaminants.	Retained for further evaluation.
			Separation	Separation techniques concentrate contaminated solids through physical and chemical means. These processes seek to detach contaminants from their medium (i.e., the soil, sand, and/or binding material that contains them).	Rejected. Generally not used for chlorinated VOCs.
			Soil Washing	Contaminants sorbed onto the soil particles are separated from soil in an aqueous-based system. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.	Rejected. Generally not used for chlorinated VOCs.
			Solidification / Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions/interactions are induced to help remove organics and heavy metals or otherwise prevent solubilization of contaminants.	Rejected. Not used for chlorinated VOCs.
			Chemical Extraction	Waste contaminated soil and extractant are mixed in an extractor, dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment and further use.	Retained for further evaluation.
			Chemical Reduction / Oxidation	Reduction/oxidation chemically converts hazardous contaminants to non hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The reducing/oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, and chlorine. Chemical oxidation is often enhanced using ultraviolet (UV) irradiation or chemical catalysts.	Retained for further evaluation.
Disposal		On Site	New On Site RCRA Landfill	Excavated soil is permanently disposed of in a centrally-located, new onsite RCRA landfill.	Retained for further evaluation.
		Off Site	RCRA Landfill (Hazardous or Non Hazardous)	Excavated material (treated or untreated) is disposed of in a RCRA Subtitle C or D landfill depending on RCRA classification.	Retained for further evaluation.

[shaded box] Technology / process option eliminated from further consideration.

Table 4-3
Evaluation of Technologies and Process Options for Groundwater
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Does not achieve any measure of remediation or meet RAOs.	Readily implementable since no action is taken.	Negligible
Institutional Controls	Access and Use Restrictions	Land Use and Deed Restrictions	Can effectively prevent exposure and reduce risk. Does not actively reduce mobility, toxicity, or volume.	Readily implementable.	Low capital; low O&M
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater	Does not achieve any measure of remediation or meet RAOs. Useful for tracking contaminant migration and/or effectiveness of remedial actions. Used in conjunction with other technologies.	Readily implementable. No construction or operation is necessary. Equipment, services, and personnel are readily available and procedures are in place.	Low capital; low to moderate O&M
Containment/Removal	Subsurface Barriers	Physical Control	Would effectively minimize the potential for exposure to contaminated groundwater, although it does not treat contamination.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Moderate capital; low O&M
	Extraction Wells	All Processes	Effective in partial removal of contaminated groundwater from an aquifer and in providing containment of groundwater plume.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Low to moderate capital; moderate O&M
	Well Points [shaded: eliminated]	All Processes [shaded: eliminated]	Not cost effective in aquifers deeper than 20 ft bgs.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Low capital; low to moderate O&M
	Subsurface Drains	All Processes	Effective in removing contaminated groundwater from an aquifer. Used in conjunction with groundwater treatment and/or hydraulic controls.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Moderate capital; moderate O&M
	Phytoremediation	All Processes	Effective in assisting with hydraulic containment and groundwater treatment but only for shallow areas, low VOC concentrations, and specific VOC species.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Low to moderate capital; moderate
Treatment	In Situ	Air Sparging	Heterogeneous subsurface can decrease effectiveness significantly. Reduces contaminants below and above water table.	Easily implementable with standard operation and construction techniques. Chlorinated VOCs must be captured with an SVE system.	Moderate capital; low O&M
		Enhanced Bioremediation	Testing required to determine effectiveness. Good understanding of area hydrology is required. Treats a wide variety of VOCs.	Easily implementable with standard operation and construction techniques. Rebound may require multiple iterations.	Moderate capital; low to moderate O&M
		Monitored Natural Attenuation	Good understanding of area hydrology required to ensure contaminants are not migrating through unknown pathways. Not a treatment technology.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Low capital; low to moderate O&M
		Chemical Oxidation	Testing required to select oxidizer and prove ultimate effectiveness. Good understanding of area hydrology is required. Contaminant rebound is often observed. Not as effective in source areas.	Easily implementable with standard operation and construction techniques. Oxidizers handling is a safety concern. May require permitting. Rebound may require multiple iterations.	Moderate to high capital; low to moderate O&M
		Dual Phase Extraction (DPE)	Effective process for capturing free phase organics. Used in conjunction with above groundwater and vapor treatment systems.	Easily implementable with standard operation and construction techniques.	Moderate capital; low O&M
		Enhanced DPE	Specialized DPE enhancement. Effectively releases free phase contaminants sorbed to soil during vapor recovery.	Easily implementable with standard operation and construction techniques. May require permitting.	Moderate to high capital; low O&M
		Passive/Reactive Treatment Walls	Effective in removing contaminants from groundwater. Long term treatment as groundwater is treated as it naturally moves toward the wall. Good understanding of hydrology and lithology is required.	Easily implementable with standard operation and construction techniques. Implementation becomes cost prohibitive in deeper aquifers.	Moderate to high capital; low O&M
		Thermal	Most effective in high cocentration "source" areas. High energy costs required, especially with contaminants with high boiling points.	Implementation requires vaccuum system combined with steam injection.	High capital; low to moderate O&M
		In-Well Air Stripping	Most effective in high concentration areas with high Henry's Law constants.	Implementation requires vaccuum system combined with water extraction and air injection.	Moderate to high capital; low to moderate O&M
	Ex Situ	Carbon adsorption	Effective for treating volatile organic compounds.	Already implemented. Expansion may be required.	Moderate capital and moderate O&M
		Oil-Water Separator	Effective for treating free phase contaminants in groundwater.	Already implemented. Expansion may be required.	Moderate capital and low O&M
Discharge	On Site	Existing Industrial Wastewater Treatment Facility	Effective means for disposal of treated groundwater.	Easily implemented with conventional construction materials and methods. Will require compliance with POTW pretreatment standards.	Low capital, moderate to high O&M
	Off Site	POTW	Effective proven method of disposing of treated water. Discharge permit generally required.	Easily implemented with conventional construction materials and methods. Will require compliance with POTW pretreatment standards.	Low capital, low to moderate O&M

[shaded box] Technology / process option eliminated from further consideration.

Table 4-4
Evaluation of Technologies and Process Options for Soil
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Does not achieve any measure of remediation or meet RAOs.	Readily implementable since no action is taken.	Negligible
Institutional Controls	Access and Use Restrictions	Land Use and Deed Restrictions	Can effectively prevent exposure and reduce risk.	Readily implementable.	Low
		Fencing	Can effectively prevent exposure and reduce risk.	Readily implementable. Requires long-term maintenance. Equipment, services, and personnel are readily available and procedures are in place.	Low capital; low O&M
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater	Does not achieve any measure of remediation or meet RAOs. Useful for tracking contaminant migration and/or effectiveness of remedial actions. Used in conjunction with other technologies.	Readily implementable. No construction or operation is necessary. Equipment, services, and personnel are readily available and procedures are in place.	Low capital; low O&M
Containment	Caps	Direct Access Control	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained.	Implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Moderate capital; low O&M
		Hydraulic Infiltration Control	Would be effective in reducing surface infiltration and reducing migration of contaminants.	Implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Moderate capital; low O&M
	Subsurface Barriers	Hydraulic Control	Would minimize migration of groundwater through the subsurface soil and reduce transport of contaminants through hydraulic controls.	Implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Low to moderate capital; low to moderate O&M
		Physical Control	Would minimize migration of groundwater through the subsurface soil and reduce transport of contaminants through physical barriers.	Implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Moderate capital; low O&M
	Surface Diversion / Collection	All Processes	Would minimize migration of contaminated runoff from source areas into the river. However large diversion area would be required because of the large soil footprint.	Implementable. Conventional technology. Equipment, personnel, and services readily available.	Low capital; low to moderate O&M
Removal / Extraction	Excavation	All Processes	Proven reliable technology. Would effectively reduce the potential threat to human health and ecological receptors. Short term effects include noise and fugitive dust emissions.	Easily implementable. Equipment, personnel, and services are readily available. Potential ecological impacts must be considered.	Moderate capital; negligible O&M
Treatment — In Situ	Biological	**Biodegradation**	Can be effective in combination with groundwater bioremediation below the water table. Average depth to groundwater is 15-20 feet makes this a less viable option.	Implementation requires raising the water table elevation to distribute nutrients and microbes. Also, monitoring and controlling biodegradation process during treatment is difficult.	Moderate capital; low O&M
		Phytoremediation	Generally limited to soils within three feet of the surface. Long duration required for remediation. Efficiencies are often too low to meet sensitive endpoints. Contaminants may still enter the food chain through animals/insects that eat plant containing contaminants.	Readily implementable. Ex situ treatment via wetland troughs may be necessary for deeper contamination. Requires a large surface of land. Modification of ground surface at the site may be necessary to prevent flooding or erosion.	Low to moderate capital; low to moderate O&M
	Physical / Chemical	**Chemical Reduction / Oxidation**	Extensive treatability testing would be required to evaluate the overall effectiveness of the process. Incomplete oxidation or formation of intermediate contaminants may occur depending on the contaminants and the oxidizing agents used.	Implementation requires raising the water table to distribute chemicals throughout vadose zone. Solids must be in solution. Waste composition must be well-known to prevent the inadvertent production of a more hazardous end product.	Moderate capital; moderate O&M
		Soil Mixing	Treatability testing would be required to evaluate the overall effectiveness of the process. Incomplete oxidation or formation of intermediate contaminants may occur, and the potential effects of the oxidant on the existing treatment system must be considered.	Readily implementable. A relatively new technology with limited data availability on previous performance.	Low to moderate capital; low O&M
		Electrokinetic Separation	Moisture content below 10% greatly reduces effective separation. More effective in low permeability soils. Not widely used.	Implementation tools not readily available. More widely used in sediments.	Moderate to high capital; moderate O&M

Technology / process option eliminated from further consideration.

Table 4-4
Evaluation of Technologies and Process Options for Soil
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action		Remedial Technology	Process Option	Effectiveness	Implementability	Cost
Treatment	In Situ	Physical / Chemical	Soil Vapor Extraction (SVE)	Preferred method for soils VOC remediation with large vadose zone. Effectiveness decreased in lower permeability soils.	Implementable. Well known technology. Difficult to implement below water table and in low permeability sites.	Low to moderate capital; low to moderate O&M
		Thermal	**Vitrification**	Very high temperatures (1,600-2,000 C) required, resulting in significant energy requirements. Cost effectiveness decreases at large sites such as this one to other technologies because of energy costs.	Implementation problems occur where metals concentration in soils exceed their solubility in glass, or arsenic is present in waste. Safe effective treatment cannot be assured when pockets of vapor exist beneath the site.	Very high capital; low O&M
			Electrical Resistance Heating (ERH)	Significant energy requirements to effectively heat soil. Cost effectiveness decreases at large sites such as this one to other technologies because of energy costs. Generally combined with soil vapor extraction. Good for high concentration source areas and short term treatment.	Must be implemented by a small field of qualified contractors. Fairly well known technology. Relatively easy to implement below water table.	Very high capital; low long-term O&M
			Thermal Conductive Heating	High temperatures (650-800 C) required, resulting in significant energy requirements. Cost effectiveness decreases at large sites such as this one to other technologies because of energy costs.	Implementable. Fairly well known technology. Difficult to implement below water table because significant energy would be used to heat groundwater.	Very high capital; low O&M
			Steam Injection	Cost effectiveness decreases with volume compared to other technologies. Moderate to high soil permeability required. Also, impermeable surface generally required below treatment area. Bedrock depths are as low as 110 feet in some areas of this site, decreasing the effectiveness of this technology in these areas.	Implementation problems occur where low moisture content exists in subsurface. Technology is well known and fairly straightforward to implement.	High capital; low O&M
	Ex Situ	Thermal	Incineration	High temperatures (870-1,200 C) required, resulting in significant energy requirements. The presence of metals may hinder the overall process. Off gases require treatment.	Extensive performance and permitting requirements must be met. Otherwise technology is very well known.	High capital; high O&M
			Thermal Desorption	Preferred technology for chlorinated VOC soils if ex-situ remediation is required. High energy requirements.	Implementation is well known. Clay and silty soils increase reaction time.	High capital; high O&M
			Vitrification	Very high temperatures (1,600-2,000 C) required, resulting in significant energy requirements. Cost effectiveness decreases with volume compared to other technologies.	Implementation problems occur where metals concentration in soils exceed their solubility in glass, or arsenic is present in waste. Extensive material handling needed to prepare soil or sediment for treatment.	High capital; moderate O&M
		Biological	Solid Phase	Biopiles, land farming, and composting treatments are proven technologies for nonhalogenated VOCs, but effectiveness varies significantly for chlorinated VOCs. Large footprint of available land required for treatment.	Implementation is straightforward and well known, combined with excavation.	Moderate capital, moderate O&M
			Slurry Phase	Primarily used for nonhalogenated compounds.	Implementation issues arise with heterogeneous soils, high fines content soils. Treatability study required.	High capital; high O&M
		Physical / Chemical	**Dehalogenation**	Treatment for halogenated VOCs, however not targeted for chlorinated ethenes, which increases costs significantly. Not for large volumes.	Not generally used for large-scale volumes.	High capital; high O&M
			Chemical Extraction	Effective and reliable method for removing contaminants. Traces of chemical would remain in the treated solid, thus the toxicity of the chemical is an important consideration.	Control of emissions and leachate may be required. Some extraction chemicals may be toxic to some organisms, thus requiring very efficient separation of extraction chemical from solids before disposal.	High capital; moderate O&M
			Chemical Reduction / Oxidation	Extensive treatability testing would be required to evaluate the overall effectiveness of the process. Incomplete oxidation or formation of intermediate contaminants may occur depending on the contaminants and the oxidizing agents used.	Solids must be in solution. Waste composition must be well-known to prevent the inadvertent production of a more hazardous end product.	High capital; moderate O&M
		Off Site	**Waste Treatment Facility**	Not effective for large volumes of waste (soil or sediment).	Readily implementable.	Low to moderate capital; negligible O&M
Disposal		On Site	**New Onsite RCRA Landfill**	Waste is not remediated but RAOs are met with the effective containment of waste material. Applicable land disposal restrictions must be met prior to	Citing and permitting requirements could make implementation difficult.	High capital; moderate O&M
		Off Site	RCRA Landfill (Hazardous or Non Hazardous)	RAOs are met with the removal of waste from the site.	A substantial amount of waste handling and characterization may be required.	Moderate capital; low O&M

(Shaded box) Technology / process option eliminated from further consideration.

CDM

Table 4-5
Summary of Retained Technologies and Process Options for Groundwater

Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option
No Action	None	Not Applicable
Institutional Controls	Access and Use Restrictions	Land Use and Deed Restrictions
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater Monitoring
Containment	Subsurface Barriers	Physical Control
	Extraction	Extraction Wells
		Subsurface Drains / Horizontal Wells
		Phytoremediation
Treatment	In Situ	Air Sparging
		In-Well Air Stripping
		Enhanced Bioremediation
		Monitored Natural Attenuation
		Chemical Oxidation
		Dual Phase Extraction (DPE)
		Enhanced DPE
		Passive / Reactive Treatment Walls
		Thermal
	Ex Situ	Carbon Adsorption
		Oil-Water Separation
Discharge	On Site	Existing Industrial Treatment System
	Off Site	POTW

Table 4-6
Summary of Retained Technologies and Process Options for Soil
Feasibility Study Report
Former PSC Site - Rock Hill, SC

General Response Action	Remedial Technology	Process Option
No Action	None	Not Applicable
Institutional Controls	Access and Use Restrictions	Land Use and Deed Restrictions
		Fencing
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater Monitoring
Containment	Caps	Direct Access Control
		Hydraulic Infiltration Control
	Subsurface Barriers	Hydraulic Control
		Physical Control
	Surface Diversion / Collection	All Processes
Removal	Excavation	All Processes
Treatment	In Situ	Soil Mixing
		Soil Vapor Extraction (SVE)
		Thermal - Electrical Resistance Heating
		Thermal - Thermal Conductive Heating
		Thermal - Steam Injection
	Ex Situ	Incineration
		Biopiles
		Chemical Treatment
		Thermal Desorption
Disposal	Off Site	RCRA Landfill (Hazardous or Non Hazardous)

Table 5-1
Summary of Groundwater Remedial Alternatives

Feasibility Study
Former PSC Site - Rock Hill, SC

Component --------> / **Alternative**	Reassessments at 5-Year Intervals	Deed restrictions	Groundwater and surface water monitoring program	Regolith (shallow) groundwater containment system	Bedrock (deep) groundwater containment system	Groundwater treatment system upgrades	Groundwater treatment system O&M	In situ chemical oxidation in the regolith zone	Dual-phase extraction in Fuel Oil Area	Thermal-enhanced multi-phase extraction in the Fuel Oil Area	Air sparging in the regolith zone	Downgradient permeable reactive barrier in the regolith zone with biosparge wells	In Situ Thermal Treatment Using Electrical Resistance Heating	Deep soil mixing in regolith groundwater with chemical oxidant
1 - No Action	X													
2 - Institutional Controls	X	X	X											
3 - Hydraulic Containment and Onsite Physical / Chemical Treatment	X	X	X	X	X	X	X							
4 - Chemical Oxidation, Dual-Phase Extraction, and Bedrock Extraction	X	X	X		X		X	X	X					
5 - Air Sparging, Dual-Phase Extraction, and Bedrock Extraction	X	X	X		X		X		X		X			
6 - Permeable Reactive Barrier Wall, Dual-Phase Extraction, and Bedrock Extraction	X	X	X		X		X		X			X		
Combination Alternative 1 - Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Deep Soil Mixing	X	X	X	X	X	X	X			X				X
Combination Alternative 2 - Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Air Sparging	X	X	X		X		X			X	X			
Combination Alternative 3 - Hydraulic Containment, SVE, Thermal-Enhanced MPE, and In Situ Thermal Treatment	X	X	X	X	X	X	X			X			X	

Table 5-2
Summary of Soil Remedial Alternatives
Feasibility Study
Former PSC Site - Rock Hill, SC

Component --------> Alternative	Reassessments at 5-Year Intervals	Deed restrictions (including fencing)	Select building and infrastructure demolition	Excavation of VOC impacted areas above the water table	Excavation of Principal Threat Source Material	Metals excavation to 1 foot for locations above PRGs outside of VOC impacted areas	Offsite disposal for excavated materials	Onsite treatment for excavated materials	Backfill of excavated areas with clean fill and/or treated soil	Placement of 103.3 DAF cover in excavated areas formerly covered by a building or slab	Capping of VOC impacted areas (follows SC municipal solid waste landfill requirements)	Long-term O&M for cap and surface water run on controls	Soil vapor extraction (SVE) system for VOC impacted areas above the water table	SVE in Burn Pit Area *(if necessary based on additional assessment data to be collected)*	Soil mixing with oxidant in VOC impacted areas (excludes Fuel Oil and Burn Pit Areas)	In Situ Thermal Treatment Using Electrical Resistance Heating	Thermal-enhanced multi-phase extraction in the Fuel Oil Area
1 - No Action	X																
2 - Institutional Controls	X	X															
3 - Soil Excavation and Offsite Disposal	X	X	X	X		X	X		X	X							
4 - Source Containment	X	X	X			X			X		X	X					
5 - Soil Excavation and Onsite Ex Situ Treatment	X	X	X	X		X		X	X	X							
6 - Soil Vapor Extraction	X	X				X	X		X				X				
Combination Alternative 1 - Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Deep Soil Mixing	X	X	X		X	X	X		X					X	X		X
Combination Alternative 2 - Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Air Sparging	X	X			X	X	X		X				X	X			X
Combination Alternative 3 - Hydraulic Containment, SVE, Thermal-Enhanced MPE, and In Situ Thermal Treatment	X	X				X	X		X					X		X	X

Table 6-1
Summary of Groundwater Alternatives Evaluation
Feasibility Study Report
Former PSC Site - Rock Hill, SC

	Threshold Criteria		*Balancing Criteria*					
						Implementability		
Remedial Alternative	**Overall Protection of Human Health and the Environment**	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of M/T/V Through Treatment**	**Short-Term Effectiveness**	**Technical / Engineering Considerations**	**Estimated Time for Implementation after ROD (years)**	**Cost (Approximate Total Present Worth)**
1 - No Action	There is no increased protection to human health and the environment under this alternative.	Chemical-specific ARARs will not be met. Action- and location-specific ARARs are not applicable.	This alternative has no long-term effectiveness as contaminants remain accessible at the site.	No additional reduction of M/T/V is expected.	This alternative poses no short-term risks.	None.	< 1	$420,000
2 - Institutional Controls	This alternative would be protective of human health and the environment because it reduces access to contaminants at the site, thus limiting potential exposures.	Chemical-specific ARARs will not be met. Action- and location-specific ARARs are not applicable.	This alternative will be effective as long as institutional controls are maintained and monitoring is conducted to ensure that additional risks do not arise.	No additional reduction of M/T/V is expected.	This alternative poses no short-term risks.	None.	1	$1,673,000
3 - Hydraulic Containment	This alternative would be protective of human health because it reduces mobilization of contaminants to other areas.	Contaminants above chemical-specific ARARs would still exist under this alternative, but migration would be limited. Action- and location- specific ARARs are expected to be met.	RGs would not be met on site but the containment system would minimize the mobility of contaminants so that they cannot migrate off site. Long-term extraction and groundwater treatment would be required.	Mobility would be limited but toxicity and volume reductions would be minimal and only occur through above ground treatment of extracted groundwater.	Minimal short-term risks are expected under this alternative. Groundwater extraction and treatment would continue for more than 30 years.	None.	1	$7,695,000
4 - In Situ Chemical Oxidation	This alternative would protect human health and the environment by treating contaminants to below RGs and minimizing mobilization of contaminated groundwater in bedrock.	Action- and location-specific ARARs are applicable and expected to be met. Chemical-specific ARARs would likely be met in regolith but the time frame is uncertain for contaminant concentration reduction through monitored natural attenuation (MNA) following chemical oxidation.	Organic contaminants would be permanently destroyed with chem-ox but multiple injections may be required in high concentration areas. MNA may be effective following injections, but the time frame is not certain for contaminant destruction to meet RGs.	The toxicity and volume of contaminants would be significantly reduced in the regolith zone. The mobility of bedrock groundwater would be reduced and the toxicity and volume of bedrock contaminants would be expected to decline following chem ox in the regolith zone.	Workers would be exposed to moderate risk due to chemical handling. Treatment will likely last 2-4 years, depending on the amount of injections required.	Bench- and pilot-scale testing would be required. Subsurface heterogeneities would make effective dispersion of oxidants difficult.	4	$32,029,000
5 - In Situ Air Sparging	This alternative would protect human health and the environment by treating contaminants to below RGs and minimizing mobilization of contaminated groundwater in bedrock.	Action- and location-specific ARARs are applicable and expected to be met. Chemical-specific ARARs would likely be met in regolith but the time frame is uncertain for contaminant concentration reduction through MNA following air sparging.	Organic contaminants would be not be destroyed, but would be mobilized into the vadose zone where they would be removed with soil vapor extraction (SVE). MNA may be effective following air sparging, but the timeframe is not certain for contaminant destruction to meet RGs.	The toxicity and volume of contaminants would be significantly reduced in the regolith zone. The mobility of bedrock groundwater would be reduced and the toxicity and volume of bedrock contaminants would be expected to decline following air sparging in the regolith zone.	Workers would be exposed to low-to moderate-risk due to potential off gases with the SVE system. Treatment will likely last 8-10 years because of the large treatment area.	Bench- and pilot-scale testing would be required. Subsurface heterogeneities may leave pockets of groundwater untreated.	10	$16,713,000
6 - Permeable Reactive Barrier Wall	This alternative would protect human health and the environment by minimizing migration of contaminated groundwater to the adjacent creek. Long term monitoring would be required to document potential future offsite contaminant migration.	Action- and location-specific ARARs are applicable and expected to be met. Contaminants would persist above chemical-specific ARARs upgradient of the reactive wall beyond the 30-year evaluation period.	Organic contaminants would be destroyed when passing through the reactive barrier wall, but contaminants upgradient of the wall would remain in groundwater. Migration of contaminants remaining in bedrock groundwater would be limited. Long-term monitoring would be required.	The M/T/V of contaminants migrating from the industrial portion of the site would be significantly reduced. However, reduction in the toxicity and volume of contaminants remaining on site would be minimal.	Workers would be exposed to moderate risk during construction of the reactive barrier wall. Construction would likely be completed within 6 months, with an additional 1-2 years required for design, procurement, and treatability testing.	Bench- and pilot-scale testing would be required. Subsurface boulders may cause problems with wall installation near the alluvium.	2	$16,893,000

Table 6-2
Summary of Soil Alternatives Evaluation
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Remedial Alternative	*Threshold Criteria*		*Balancing Criteria*					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability: Technical / Engineering Considerations	Implementability: Estimated Time for Implementation after ROD (years)	Cost (Approximate Total Present Worth)
1 - No Action	There is no increased protection to human health and the environment under this alternative.	Chemical-specific ARARs would not be met. Action- and location-specific ARARs are not applicable.	This alternative has no long-term effectiveness as contaminants remain accessible at the site.	No additional reduction of M/T/V is expected.	This alternative poses no short-term risks.	None.	< 1	$418,000
2 - Institutional Controls	This alternative would be protective of human health and the environment because it reduces access to contaminants at the site, thus limiting potential exposures.	Chemical-specific ARARs would not be met. Action- and location-specific ARARs are not applicable.	This alternative will be effective as long as institutional controls are maintained and monitoring is conducted to ensure that additional threats do not arise.	No additional reduction of M/T/V is expected.	This alternative poses no short-term risks. Building demolition may increase the risk of exposure.	None.	1	$604,000
3 - Excavation and Offsite Disposal	This alternative eliminates exposure pathways and reduces the level of risk. It removes contamination and reduces migration to surface water and groundwater.	Chemical-specific ARARs would be met through excavation and offsite disposal. Action- and location-specific ARARs are applicable and expected to be met.	This alternative is effective because contaminants are removed from the site. With this alternative, there is a high level of assurance for complete source removal.	The M/T/V of contaminants in soil would be significantly reduced through removal. No treatment would occur. Excavation may increase contaminant mobility in the short term.	Excavation and grading may result in potential release of dust and noise nuisance from the use of heavy equipment. Building demolition may increase risk of exposure to asbestos.	Leachability criteria would need to be met if material is disposed at a solid waste landfill. Excavation may require shoring to stabilize the excavation pits. Building demolition would be required prior to excavation.	2	$32,308,000
4 - Source Containment	This alternative would be protective of human health because it reduces access to contaminants and minimizes future releases.	Contaminants above chemical-specific ARARs would still exist under this alternative, but they would be isolated under a cap. Action- and location-specific ARARs are applicable and expected to be met.	This alternative will reduce long-term threats to human health and will be effective as long as cap integrity is not compromised and institutional controls are maintained.	The toxicity and volume of contaminants are not reduced, but mobility would be minimized through installation of a cap.	Moderate short-term risks are expected under this alternative. They include potential dust generation, noise, and vehicular traffic throughout the duration of cap installation. Proper procedures would be implemented to reduce risks. Building demolition may increase risk of exposure.	Building demolition would be required prior to capping.	1	$4,936,000
5 - Source Removal, Ex Situ Treatment, and Onsite Reuse	This alternative eliminates exposure pathways and reduces the level of risk. It removes contamination and reduces migration to surface water and groundwater.	Chemical-specific ARARs would be met through excavation and onsite treatment. Action- and location-specific ARARs are applicable and expected to be met.	This alternative is effective because contaminants are treated ex-situ before being replaced in the excavation pits.	The M/T/V of contaminants in soil would be significantly reduced through onsite treatment. Excavation may increase contaminant mobility in the short term.	This alternative is expected to have the highest short-term risk compared to other alternatives due to the number of onsite activities, required sequencing, and open excavation pits.	Large space requirements needed for on site treatment. Excavation may require shoring to stabilize the excavation pits. Building demolition would be required prior to excavation.	4	$24,459,000
6A - Soil Vapor Extraction (SVE)	This alternative would protect human health and the environment by treating contaminants to below RGs in soil.	Action- and location-specific ARARs are applicable and expected to be met. Chemical-specific ARARs would likely be met.	Organic contaminants would not be destroyed, but would be mobilized into the vadose zone where they would be removed with SVE.	The M/T/V of contaminants in soil would be significantly reduced through SVE.	Workers would be exposed to low- to moderate-risk due to potential off gases with the SVE system. Treatment will likely last 8-10 years because of the large treatment area.	Bench- and pilot-scale testing would be required. Subsurface heterogeneities may cause problems with uniform treatment.	10	$9,528,000
6B - In Situ Thermal Enhanced SVE	This alternative would protect human health and the environment by treating contaminants to below RGs in soil.	Action- and location-specific ARARs are applicable and expected to be met. Chemical-specific ARARs would likely be met.	Some organic contaminants would be destroyed via thermal treatment while others would be mobilized into the vadose zone where they would be removed with SVE.	The M/T/V of contaminants in soil would be significantly reduced through SVE. Thermal enhancement would offer additional assurance of removal.	Workers would be exposed to moderate risk due to potential off gases with the SVE system and the high voltage equipment required for thermal treatment. Treatment will likely last 8-10 years because of the large treatment area.	Bench- and pilot-scale testing would be required.	5	$45,462,000

Table 6-3
Summary of Combination Groundwater and Soil Alternatives Evaluation
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Remedial Alternative	*Threshold Criteria*		*Balancing Criteria*					
						Implementability		
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Technical / Engineering Considerations	Estimated Time for Implementation after ROD (years)	Cost (Approximate Total Present Worth)
1 - Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Deep Soil Mixing	This alternative would protect human health and the environment by removing or treating contaminants in soil to below RGs. Groundwater treatment would be limited but mobility of contaminants in groundwater would be reduced through containment.	Action- and location-specific ARARs are applicable and expected to be met. Chemical-specific ARARs would likely be met in soil. For groundwater, contaminants above RGs would still exist though migration would be limited.	Organic contaminants in soil would be removed via excavation, destroyed via deep soil mixing with oxidant, or mobilized into the vadose zone and removed with SVE. Contaminants would remain in regolith and bedrock groundwater but migration would be limited.	M/T/V of contaminants in soil would be significantly reduced. Mobility would also be reduced in groundwater though limited toxicity or volume reductions would occur.	Workers would be exposed to moderate risk due to potential off-gases from the SVE system, exposure to oxidant, soils disturbance during excavation and well installation, and the length of time to implement this alternative.	Bench- and pilot-scale testing would be required. Subsurface heterogeneities may cause problems with uniform treatment.	5	$43,242,000
2 - Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Air Sparging	This alternative would protect human health and the environment by treating contaminants to below RGs and minimizing mobilization of contaminated groundwater in bedrock.	Action- and location-specific ARARs are applicable and expected to be met. Chemical-specific ARARs would likely be met in soil and regolith regolith groundwater. RGs would not be initially met for bedrock groundwater, but concentrations would be expected to decline significantly after source removal / treatment.	Organic contaminants in soil would be removed via excavation or mobilized into the vadose zone and removed with SVE. Organic contaminants in groundwater would be removed via air sparging and dual-phase extraction. Some contaminants may remain in bedrock groundwater though migration would be limited.	M/T/V of contaminants in soil and regolith groundwater would be significantly reduced. The mobility of bedrock groundwater would also be reduced and the toxicity and volume of contaminants would likely decline once the source material was treated or removed.	Workers would be exposed to moderate risk due to potential off-gases from the SVE system, soils disturbance during excavation and well installation, and the length of time to implement this alternative.	Bench- and pilot-scale testing would be required. Subsurface heterogeneities may cause problems with uniform treatment.	10	$28,960,000
3 - Hydraulic Containment, SVE, Thermal-Enhanced MPE, and In Situ Thermal Treatment	This alternative is expected to be the most protective of human health and the environment due to the destructive nature of thermal treatment.	Action- and location-specific ARARs are applicable and expected to be met. Chemical-specific ARARs would likely be met in soil and regolith regolith groundwater. RGs would not be initially met for bedrock groundwater, but concentrations would be expected to decline significantly after source treatment.	Organic contaminants in soil and groundwater would be destroyed through thermal treatment. Some contaminants may remain in bedrock groundwater though migration would be limited.	M/T/V of contaminants in soil and regolith groundwater would be significantly reduced. The mobility of bedrock groundwater would also be reduced and the toxicity and volume of contaminants would likely decline once the source material was treated.	Workers would be exposed to moderate risk due to potential off-gases from the thermal treatment system, use of high voltage equipment, and the length of time to implement this alternative.	The number of vendors is limited. Additional data collection would likely be required to accurately estimate costs as cost is very sensitive to the number of months of operation (e.g., one additional month of operation is a significant add-on expense).	5	$35,854,000

Table 6-4
Comparative Analysis of Groundwater Alternatives
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Remedial Alternative	*Criteria Rating*						Approximate Present Worth
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability	
1 - No Action	0	0	0	0	0	5	$420,000
2 - Institutional Controls	1.5	1	1.5	0	3	5	$1,673,000
3 - Hydraulic Containment	2.5	2	2	2	4	4	$7,695,000
4 - In Situ Chemical Oxidation	3.5	4	4	4	3	3	$32,029,000
5 - In Situ Air Sparging	3.5	4	4	4	3.5	3	$16,713,000
6 - In Situ Permeable Reactive Barrier Wall	3	2.5	2.5	2.5	3	2.5	$16,893,000
Combination Alternative 1, GW components: Hydraulic Containment, Thermal-Enhanced MPE, and Deep Soil Mixing	3	3.5	3	3	3	3	$43,242,000[1]
Combination Alternative 2, GW Components: Hydraulic Containment, Thermal-Enhanced MPE, and Air Sparging	3.5	4	4	4	3.5	3	$28,960,000[1]
Combination Alternative 3, GW Components: Hydraulic Containment, Thermal-Enhanced MPE, and In Situ Thermal Treatment	3.5	4	4.5	4	3.5	3.5	$35,854,000[1]

Notes:

A ranking of "0" indicates that the criterion is not met while a ranking of "5" indicates that the criterion is completely met.

Combination alternative rankings are based on the groundwater component only.

[1] Total cost including both soil and groundwater components.

Table 6-5
Comparative Analysis of Soil Alternatives
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Remedial Alternative	*Criteria Rating*						Approximate Present Worth
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability	
1 - No Action	0	0	0	0	0	5	$418,000
2 - Institutional Controls	1.5	1	1.5	0	3	5	$604,000
3 - Excavation and Offsite Disposal	5	5	5	4.5	3	3.5	$32,308,000
4 - Source Containment	2.5	2	2.5	2	3.5	4	$4,936,000
5 - Source Removal, Ex Situ Treatment, and Onsite Reuse	5	5	5	4.5	1	2	$24,459,000
6A - Soil Vapor Extraction (SVE)	3.5	3.5	3.5	3.5	3	4	$9,528,000
6B - In Situ Thermal Enhanced SVE	4	4	4	4	3	3	$45,462,000
Combination Alternative 1, Soil Components: Select Excavation, SVE, and Deep Soil Mixing	4	4	4	4	3	3	$43,242,000[1]
Combination Alternative 2, Soil Components: Select Excavation and SVE	3.5	3.5	4	4	3	3	$28,960,000[1]
Combination Alternative 3, Soil Components: SVE and In Situ Thermal Treatment	4.5	4.5	4.5	5	3.5	4	$35,854,000[1]

Notes:

A ranking of "0" indicates that the criterion is not met while a ranking of "5" indicates that the criterion is completely met.

Combination alternative rankings are based on the soil component only.

[1] Total cost including both soil and groundwater components.

CDM

Appendix A
Remedial Alternative Cost Estimates

Groundwater Remedial Alternative Cost Summary

Feasibility Study Report
Former PSC Site - Rock Hill, SC

Alternative	***Description***	***Construction Cost***	***Present Worth O&M Cost***	**Total Present Worth Cost**
1	No Action	$0	$420,000	**$420,000**
2	Institutional Controls	$0	$1,673,000	**$1,673,000**
3	Hydraulic Containment	$1,239,875	$6,455,000	**$7,695,000**
4	In Situ Treatment - Chemical Oxidation	$27,607,125	$4,422,000	**$32,029,000**
5	In Situ Treatment - Air Sparging	$9,030,125	$7,683,000	**$16,713,000**
6	In Situ Treatment - Reactive Barrier Wall	$12,917,938	$3,974,570	**$16,893,000**

Notes:
Total present worth costs are rounded to the nearest $1,000.

PRESENT WORTH COST
GROUNDWATER ALTERNATIVE 1: NO ACTION
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
NO CAPITAL COSTS RELATED TO THIS ALTERNATIVE				
TOTAL CONSTRUCTION COST				$0
PRESENT WORTH O&M COST				$420,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$420,000**

OPERATION AND MAINTENANCE COST
GROUNDWATER ALTERNATIVE 1: NO ACTION
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$20,000	$4,000	30	$74,671
Environmental Sampling/Analysis (1 event every 5 yrs)	lump sum	1	$40,000	$8,000	30	$149,343
Report Preparation (every 5 years)	lump sum	1	$30,000	$6,000	30	$112,007
SITE INSPECTIONS & MAINTENANCE Cost is Included in Soil Alternatives						
Subtotal						$336,021
Contractor Fee (10% of O&M Cost)						$33,602
Legal Fees, Licenses & Permits (5% of O&M Cost)						$16,801
Contingency (10% of O&M Cost)						$33,602
TOTAL						$420,000

Assumptions:
Environmental sampling assumes sampling and analyis of seventy-five monitoring wells along with five surface water locations.

PRESENT WORTH COST
GROUNDWATER ALTERNATIVE 2: INSTITUTIONAL CONTROLS
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
IMPLEMENT DEED RESTRICTIONS - Included in Soil Alternatives				
Subtotal - Capital Cost				$0
Contractor Fee (10% of Capital Cost)				$0
Legal Fees, Licenses & Permits (5% of Capital Cost)				$0
Engineering & Administrative (15% of Capital Cost)				$0
Subtotal				$0
Contingency (25% of Subtotal)				$0
TOTAL CONSTRUCTION COST				$0
PRESENT WORTH O&M COST				$1,673,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$1,673,000**

OPERATION AND MAINTENANCE COST
GROUNDWATER ALTERNATIVE 2: INSTITUTIONAL CONTROLS
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$20,000	$4,000	30	$74,671
Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$40,000	$40,000	30	$746,714
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit Included in Soil Alternatives						
Subtotal						$1,194,742
Contractor Fee (10% of O&M Cost)						$119,474
Legal Fees, Licenses & Permits (5% of O&M Cost)						$59,737
Contingency (25% of O&M Cost)						$298,685
TOTAL						$1,673,000

Assumptions:
Environmental sampling assumes sampling and analyis of seventy-five monitoring wells along with five surface water locations.

PRESENT WORTH COST
GROUNDWATER ALTERNATIVE 3: HYDRAULIC CONTAINMENT
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$20,000	$20,000
CONTRACTOR GENERAL CONDITIONS	month	3	$10,000	$30,000
REGOLITH (SHALLOW) CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$6,000	$36,000
Extraction System Expansion (controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
BEDROCK CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$12,000	$72,000
Extraction System Expansion (controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
GROUNDWATER TREATMENT SYSTEM UPGRADES - 30 GPM Additional Capacity				
Tank Upgrades	ls	1	$250,000	$250,000
Pump Upgrades	ls	1	$75,000	$75,000
Carbon Adsorption Upgrades	ls	1	$100,000	$100,000
Subtotal - Capital Cost				$763,000
Contractor Fee (10% of Capital Cost)				$76,300
Legal Fees, Licenses & Permits (5% of Capital Cost)				$38,150
Engineering & Administrative (15% of Capital Cost)				$114,450
Subtotal				$991,900
Contingency (25% of Subtotal)				$247,975
TOTAL CONSTRUCTION COST				$1,239,875
PRESENT WORTH O&M COST				$6,455,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$7,695,000**

OPERATION AND MAINTENANCE COST
GROUNDWATER ALTERNATIVE 3: HYDRAULIC CONTAINMENT
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
TREATMENT SYSTEM O&M						
Carbon replacement	events/yr	4	$15,000	$60,000	30	$1,120,070
Additional Power Requirements	kWH/yr	300,000	$0.09	$27,000	30	$504,032
Monthly O&M	events/yr	12	$8,000	$96,000	30	$1,792,113
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$20,000	$4,000	30	$74,671
Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$40,000	$40,000	30	$746,714
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
Subtotal						$4,610,956
Contractor Fee (10% of O&M Cost)						$461,096
Legal Fees, Licenses & Permits (5% of O&M Cost)						$230,548
Contingency (25% of O&M Cost)						$1,152,739
TOTAL						$6,455,000

PRESENT WORTH COST
GW ALTERNATIVE 4: IN SITU CHEMICAL OXIDATION
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$20,000	$20,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	18	$10,000	$180,000
REGOLITH (SHALLOW) IN SITU CHEM-OX SYSTEM				
Additional Site Characterization	ls	1	$20,000	$20,000
Bench-scale/Pilot testing	ls	1	$250,000	$250,000
Permitting	ls	1	$30,000	$30,000
Injection Wells (15-ft ROI, 2-20' screened wells/location)	each	1,120	$2,500	$2,800,000
Injection System Construction	ls	1	$1,000,000	$1,000,000
PERSULFATE INJECTION - 2 EVENTS				
3-man injection team - 100 injection rounds (10 wells/round)	event	2	$750,000	$1,500,000
Sodium Persulfate (1,125 lb/well)	tons	1,260	$2,600	$3,276,000
EDTA Activator (675 lb/well)	tons	756	$8,000	$6,048,000
Verification Monitoring - 12 wells	month	36	$18,000	$648,000
BEDROCK CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$12,000	$72,000
Extraction System Expansion controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
DUAL PHASE EXTRACTION - FUEL OIL AREA				
Dual Phase System Construction (25-ft depth)	sf	65,000	$15	$975,000
Additional Wells (25-ft spacing, 1 GPM per well)	each	40	$2,000	$80,000
Subtotal - Capital Cost				$16,989,000
Contractor Fee (10% of Capital Cost)				$1,698,900
Legal Fees, Licenses & Permits (5% of Capital Cost)				$849,450
Engineering & Administrative (15% of Capital Cost)				$2,548,350
Subtotal				$22,085,700
Contingency (25% of Subtotal)				$5,521,425
TOTAL CONSTRUCTION COST				$27,607,125
PRESENT WORTH O&M COST				$4,422,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$32,029,000**

OPERATION AND MAINTENANCE COST
GW ALTERNATIVE 4: IN SITU CHEMICAL OXIDATION
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
TREATMENT SYSTEM O&M						
Carbon replacement	events/yr	4	$10,000	$40,000	30	$746,714
Additional Power Requirements	kWH/yr	100,000	$0.09	$9,000	30	$168,011
Monthly O&M	events/yr	12	$6,000	$72,000	30	$1,344,084
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$10,000	$2,000	30	$37,336
Regolith Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$25,000	$25,000	10	$209,161
Bedrock Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$15,000	$15,000	30	$280,018
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
Subtotal						$3,158,680
Contractor Fee (10% of O&M Cost)						$315,868
Legal Fees, Licenses & Permits (5% of O&M Cost)						$157,934
Contingency (25% of O&M Cost)						$789,670
TOTAL						$4,422,000

Assumptions:
Regolith environmental sampling assumes sampling and analyis of fifty regolith monitoring wells.
Bedrock environmental sampling assumes sampling and analyis of twenty-five bedrock monitoring wells along with five surface water locations.

PRESENT WORTH COST
GROUNDWATER ALTERNATIVE 5: AIR SPARGING
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION/DEMOBILIZATION	ls	1	$20,000	$20,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	24	$10,000	$240,000
IN-SITU TREATMENT - AIR SPARGING				
Air Sparging Pilot Study	ls	1	$100,000	$100,000
Air Sparging Injection Well Installation (15-ft ROI)	wells	560	$2,000	$1,120,000
SVE Well Installation (30-ft radius)	wells	140	$500	$70,000
Monitor Well Installation	wells	50	$2,000	$100,000
Air Sparging System Installation - 10 cfm/well	treat. area	10	$150,000	$1,500,000
SVE System Installation	treat. area	3	$250,000	$750,000
Geomembrane Soil Cover	sy	44,000	$10	$440,000
BEDROCK CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$12,000	$72,000
Extraction System Expansion (controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
DUAL PHASE EXTRACTION - FUEL OIL AREA				
Dual Phase System Construction (25-ft depth)	sf	65,000	$15	$975,000
Additional Wells (20-ft spacing, 1 GPM per well)	each	40	$2,000	$80,000
Subtotal - Capital Cost				$5,557,000
Contractor Fee (10% of Capital Cost)				$555,700
Legal Fees, Licenses & Permits (5% of Capital Cost)				$277,850
Engineering & Administrative (15% of Capital Cost)				$833,550
Subtotal				$7,224,100
Contingency (25% of Subtotal)				$1,806,025
TOTAL CONSTRUCTION COST				$9,030,125
PRESENT WORTH O&M COST				$7,683,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$16,713,000**

OPERATION AND MAINTENANCE COST
GROUNDWATER ALTERNATIVE 5: AIR SPARGING
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
ENV. MONITORING OF AIR SPARGE SYSTEM						
Air Sampling and Analysis	events/yr	12	$2,000	$24,000	10	$200,795
Groundwater Sampling and Analysis	events/yr	12	$5,000	$60,000	10	$501,986
Air Sparging System O&M	yr	1	$100,000	$100,000	10	$836,644
20-hp Blower Power Requirements (0.75 kW/hp)	yr	1	$35,400	$35,400	10	$296,172
10-hp Compressor Power Requirements (0.75 kW/hp)	yr	1	$59,000	$59,000	10	$493,620
Off-Gas Treatment	Included in air sparging system installation costs					
TREATMENT SYSTEM O&M						
Carbon replacement	events/yr	4	$10,000	$40,000	30	$746,714
Additional Power Requirements	kWH/yr	100,000	$0.09	$9,000	30	$168,011
Monthly O&M	events/yr	12	$6,000	$72,000	30	$1,344,084
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$10,000	$2,000	30	$37,336
Regolith Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$25,000	$25,000	10	$209,161
Bedrock Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$15,000	$15,000	30	$280,018
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
Subtotal						$5,487,897
Contractor Fee (10% of O&M Cost)						$548,790
Legal Fees, Licenses & Permits (5% of O&M Cost)						$274,395
Contingency (25% of O&M Cost)						$1,371,974
TOTAL						$7,683,000

Assumptions:
Regolith environmental sampling assumes sampling and analyis of fifty regolith monitoring wells.
Bedrock environmental sampling assumes sampling and analyis of twenty-five bedrock monitoring wells along with five surface water locations.

PRESENT WORTH COST
GROUNDWATER ALTERNATIVE 6: PERMEABLE REACTIVE BARRIER WALL
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION/DEMOBILIZATION	ls	1	$20,000	$20,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	6	$20,000	$120,000
BEDROCK CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$12,000	$72,000
Extraction System Expansion (controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
DUAL PHASE EXTRACTION - FUEL OIL AREA				
Dual Phase System Construction (25-ft depth)	sf	65,000	$15	$975,000
Additional Wells (25-ft spacing, 1 GPM per well)	each	40	$2,000	$80,000
PERMEABLE REACTIVE WALL				
Bench-Scale Study	ls	1	$150,000	$150,000
Additional Site Characterization	ls	1	$100,000	$100,000
3-foot Barrier Wall Installation (800 ft long, 60 ft deep)	cy	6,000	$1,000	$6,000,000
Air Sparging Injection Well Installation (15-ft spacing)	wells	55	$3,500	$192,500
Air Sparging System Installation - 10 cfm/well	ls	1	$150,000	$150,000
Subtotal - Capital Cost				$7,949,500
Contractor Fee (10% of Capital Cost)				$794,950
Legal Fees, Licenses & Permits (5% of Capital Cost)				$397,475
Engineering & Administrative (15% of Capital Cost)				$1,192,425
Subtotal				$10,334,350
Contingency (25% of Subtotal)				$2,583,588
TOTAL CONSTRUCTION COST				$12,917,938
PRESENT WORTH O&M COST				$3,974,570
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$16,893,000**

OPERATION AND MAINTENANCE COST
GROUNDWATER ALTERNATIVE 6: PERMEABLE REACTIVE BARRIER WALL
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
TREATMENT SYSTEM O&M						
Carbon replacement	events/yr	4	$10,000	$40,000	30	$746,714
Additional Power Requirements	kWH/yr	100,000	$0.09	$9,000	30	$168,011
Monthly O&M	events/yr	12	$6,000	$72,000	30	$1,344,084
ENV. MONITORING OF TREATMENT SYSTEM						
Groundwater Sampling and Analysis	events/yr	1	$10,000	$10,000	30	$186,678
Air Sparging System O&M	events/yr	12	$1,000	$12,000	30	$224,014
10-hp Compressor Power Requirements (0.75 kW/hp)	yr	1	$5,910	$5,910	30	$110,327
Off-Gas Treatment	Included in air sparging system installation costs					
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$20,000	$4,000	30	$74,671
Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$40,000	$40,000	30	$746,714
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
Subtotal						$3,974,570
Contractor Fee (10% of O&M Cost)						$397,457
Legal Fees, Licenses & Permits (5% of O&M Cost)						$198,728
Contingency (25% of O&M Cost)						$993,642
TOTAL						$5,564,000

Assumptions:
Regolith environmental sampling assumes sampling and analyis of fifty regolith monitoring wells.
Bedrock environmental sampling assumes sampling and analyis of twenty-five bedrock monitoring wells along with five surface water locations.

Soil Remedial Alternative Cost Summary
Feasibility Study Report
Former PSC Site - Rock Hill, SC

Alternative	***Description***	***Construction Cost***	***Present Worth O&M Cost***	**Total Present Worth Cost**
1	No Action	$0	$418,000	**$418,000**
2	Institutional Controls	$81,250	$523,000	**$604,000**
3	Soil Excavation and Offsite Disposal	$31,785,000	$523,000	**$32,308,000**
4	Source Containment	$4,021,063	$915,000	**$4,936,000**
5	Soil Excavation, Ex Situ Physical/Chemical Treatment, and Onsite Disposal	$23,936,250	$523,000	**$24,459,000**
6A	In Situ Soil Vapor Extraction (SVE)	$7,833,638	$1,694,000	**$9,528,000**
6B	In Situ Thermal Enhanced SVE	$19,142,500	$26,319,000	**$45,462,000**

Notes:
Total present worth costs are rounded to the nearest $1,000.

PRESENT WORTH COST
ALTERNATIVE 1: NO ACTION
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
Subtotal - Capital Cost				$0
Contractor Fee (10% of Capital Cost)				$0
Legal Fees, Licenses & Permits (5% of Capital Cost)				$0
Engineering & Administrative (15% of Capital Cost)				$0
Subtotal				$0
Contingency (25% of Subtotal)				$0
TOTAL CONSTRUCTION COST				$0
PRESENT WORTH O&M COST				$418,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$418,000**

OPERATION AND MAINTENANCE COST
ALTERNATIVE 1: NO ACTION
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SITE INSPECTIONS & MAINTENANCE						
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
Report Preparation (every 5 years)	lump sum	1	$30,000	$6,000	30	$112,007
ENVIRONMENTAL SAMPLING - Included in Groundwater Remedial Options						
Subtotal						$298,685
Contractor Fee (10% of O&M Cost)						$29,869
Legal Fees, Licenses & Permits (5% of O&M Cost)						$14,934
Contingency (25% of O&M Cost)						$74,671
TOTAL						$418,000

PRESENT WORTH COST
ALTERNATIVE 2: INSTITUTIONAL CONTROLS
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
Subtotal - Capital Cost				$50,000
Contractor Fee (10% of Capital Cost)				$5,000
Legal Fees, Licenses & Permits (5% of Capital Cost)				$2,500
Engineering & Administrative (15% of Capital Cost)				$7,500
Subtotal				$65,000
Contingency (25% of Subtotal)				$16,250
TOTAL CONSTRUCTION COST				$81,250
PRESENT WORTH O&M COST				$523,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$604,000**

OPERATION AND MAINTENANCE COST
ALTERNATIVE 2: INSTITUTIONAL CONTROLS
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
ENVIRONMENTAL SAMPLING - Included in Groundwater Remedial Options						
Subtotal						$373,357
Contractor Fee (10% of O&M Cost)						$37,336
Legal Fees, Licenses & Permits (5% of O&M Cost)						$18,668
Contingency (25% of O&M Cost)						$93,339
TOTAL						$523,000

PRESENT WORTH COST
ALTERNATIVE 3: SOIL EXCAVATION AND OFFSITE DISPOSAL
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$40,000	$40,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	12	$20,000	$240,000
UTILITY RELOCATION (telephone, power, sewer, water)	ls	1	$200,000	$200,000
BUILDING DEMOLITION				
Warehouse Building Demo and Removal	sf	78,000	$2.5	$195,000
Scrap Steel Credit	tons	350	($300)	($105,000)
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC excavation not included	ls	0	$5,000	$0
Soil Excavation and Loading/Hauling to Treatment Area	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
EXCAVATE VOC EXCEEDANCE AREAS				
Excavation & Handling of Material	tons	210,000	$10	$2,100,000
Benching (1:1 slope) excavation	tons	82,500	$10	$825,000
Shoring (areas where benching is infeasible W of warehouse)	sf	4,800	$40	$192,000
Transport & Disposal of Non-Hazardous Material (95%)	tons	199,500	$40	$7,980,000
Transport & Disposal of Hazardous Material (5%)	tons	10,500	$350	$3,675,000
Backfill with Imported Common Fill	tons	210,000	$10	$2,100,000
Backfill with Clean/Treated Soil	tons	82,500	$6	$495,000
Cover meeting a dilution attenuation factor of 103.3	sf	78,000	$5.5	$429,000
Topsoil / Seed	sy	22,000	$6	$132,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENVIRONMENTAL CONTROLS				
Sediment & Erosion Controls				
Silt fencing around perimeters and hay bales	ft	1,000	$5	$5,000
Stormwater Collection				
6" pump & hoses	month	1	$2,000	$2,000
Frac tank	month	12	$2,000	$24,000
Excavation Pit Confirmation Sampling	samples	200	$1,500	$300,000
Air Monitoring				
4 air monitoring stations with MiniRae 3000	month	12	$3,500	$42,000
Health & Safety Equipment - 10 person team				
Tyvek, gloves, PID, etc.	day/person	2,500	$20	$50,000
Waste Characterization (1 every 500 tons)	ea	585	$1,000	$585,000
Subtotal - Capital Cost				$19,560,000
Contractor Fee (10% of Capital Cost)				$1,956,000
Legal Fees, Licenses & Permits (5% of Capital Cost)				$978,000
Engineering & Administrative (15% of Capital Cost)				$2,934,000
Subtotal				$25,428,000
Contingency (25% of Subtotal)				$6,357,000
TOTAL CONSTRUCTION COST				$31,785,000
PRESENT WORTH O&M COST				$523,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$32,308,000**

OPERATION AND MAINTENANCE COST
ALTERNATIVE 3: SOIL EXCAVATION AND OFFSITE DISPOSAL
FEASIBILITY STUDY
PSC SITE

Inflation Rate:	3.5%	Real Discount Rate:	3.4%
Nominal Discount Rate:	7%		

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
ENVIRONMENTAL SAMPLING - Included in Groundwater Remedial Options						
Subtotal						$373,357
Contractor Fee (10% of O&M Cost)						$37,336
Legal Fees, Licenses & Permits (5% of O&M Cost)						$18,668
Contingency (25% of O&M Cost)						$93,339
TOTAL						$523,000

PRESENT WORTH COST
ALTERNATIVE 4: SOURCE CONTAINMENT
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$25,000	$25,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	18	$20,000	$360,000
BUILDING DEMOLITION				
Warehouse Building Demo and Removal	sf	100,000	$2.5	$250,000
Scrap Steel Credit	tons	500	($300)	($150,000)
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC area excavation not included	ls	1	$5,000	$5,000
Soil Excavation and Loading/Hauling to Treatment Area	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
Confirmatory Sampling and Waste Characterization	each	10	$250	$2,500
CAP VOC EXCEEDANCE AREAS (one cap)				
Regrade to 2% slope	tons	17,000	$15	$255,000
18-inch (min.) Soil Cover Layer	tons	25,500	$15	$382,500
60-mil HDPE Liner	sf	300,000	$0.75	$225,000
6-inch Sand Drainage Layer	tons	10,000	$15	$150,000
Filter Fabric	sy	34,000	$4	$136,000
18-inch Common Fill Layer	tons	25,500	$15	$382,500
6-inch Topsoil/Seed	sy	34,000	$6	$204,000
Perimeter Swale for Final Drainage	ls	1	$50,000	$50,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENVIRONMENTAL CONTROLS				
Sediment & Erosion Controls (Silt Fence & Upgrade Swale)	lf	1,000	$5	$5,000
Air Monitoring				
4 air monitoring stations with MiniRae 3000	month	18	$3,500	$63,000
Health & Safety Equipment - 10 person team				
Tyvek, gloves, PID, etc.	day/person	3,750	$20	$75,000
Subtotal - Capital Cost				$2,474,500
Contractor Fee (10% of Capital Cost)				$247,450
Legal Fees, Licenses & Permits (5% of Capital Cost)				$123,725
Engineering & Administrative (15% of Capital Cost)				$371,175
Subtotal				$3,216,850
Contingency (25% of Subtotal)				$804,213
TOTAL CONSTRUCTION COST				$4,021,063
PRESENT WORTH O&M COST				$915,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$4,936,000**

OPERATION AND MAINTENANCE COST
ALTERNATIVE 4: SOURCE CONTAINMENT
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SITE INSPECTIONS & MAINTENANCE						
Stormwater Collection System Sampling and O&M	events/yr	4	$2,500	$10,000	30	$186,678
Cap Repairs	events/yr	1	$5,000	$5,000	30	$93,339
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
ENVIRONMENTAL SAMPLING - Included in Groundwater Remedial Options						
Subtotal						$653,374
Contractor Fee (10% of O&M Cost)						$65,337
Legal Fees, Licenses & Permits (5% of O&M Cost)						$32,669
Contingency (25% of O&M Cost)						$163,344
TOTAL						$915,000

PRESENT WORTH COST
ALTERNATIVE 5: SOIL EXCAVATION, EX SITU TREATMENT, AND REUSE
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION/DEMOBILIZATION	ls	1	$10,000	$10,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	48	$10,000	$480,000
UTILITY RELOCATION (telephone, power, sewer, water)	ls	1	$200,000	$200,000
BUILDING DEMOLITION				
Warehouse Building Demo and Removal	sf	78,000	$2.5	$195,000
Scrap Steel Credit	tons	350	($300)	($105,000)
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC excavation not included	ls	0	$5,000	$0
Soil Excavation and Loading/Hauling to Treatment Area	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
EXCAVATE VOC EXCEEDANCE AREAS				
Soil Excavation and Loading/Hauling to Treatment Area	tons	210,000	$10	$2,100,000
Benching (1:1 slope) excavation	tons	85,000	$10	$850,000
Shoring (areas where benching is infeasible W of warehouse)	sf	4,800	$40	$192,000
TREAT VOC EXCEEDANCE SOIL*				
Treatment System - Physical/Chemical/Biological	cu yd	140,000	$40	$5,600,000
Treatability Study	ls	1	$300,000	$300,000
Backfill with Imported Common Fill	tons	0	$10	$0
Backfill with Clean/Treated Soil	tons	295,000	$6	$1,770,000
Cover meeting a dilution attenuation factor of 103.3	sf	78,000	$5.5	$429,000
Topsoil / Seed	sy	22,000	$6	$132,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENV. MONITORING OF TREATMENT SYSTEM				
Soil Sampling - 5 per week	weeks	208	$7,500	$1,560,000
Operating & Maintenance Labor	month	48	$10,000	$480,000
ENVIRONMENTAL CONTROLS				
Sediment & Erosion Controls				
Silt fencing around perimeters and hay bales	ft	1,000	$5	$5,000
Excavation Pit Confirmation Sampling	samples	200	$1,500	$300,000
Excavation Pit stormwater Collection				
6" pump & hoses	ls	1	$2,000	$2,000
Frac tank	month	6	$2,000	$12,000
Soil Pile Leachate Collection System	ls	1	$30,000	$30,000
Air Monitoring				
4 air monitoring stations with MiniRae 3000	ls	4	$3,500	$14,000
Health & Safety Equipment - 10 person team				
Tyvek, gloves, PID, etc.	day/person	6,000	$20	$120,000
Subtotal - Capital Cost				$14,730,000
Contractor Fee (10% of Capital Cost)				$1,473,000
Legal Fees, Licenses & Permits (5% of Capital Cost)				$736,500
Engineering & Administrative (15% of Capital Cost)				$2,209,500
Subtotal				$19,149,000
Contingency (25% of Subtotal)				$4,787,250
TOTAL CONSTRUCTION COST				$23,936,250
PRESENT WORTH O&M COST				$523,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$24,459,000**

*Costs based on on soil piles

OPERATION AND MAINTENANCE COST
ALTERNATIVE 5: SOIL EXCAVATION, EX SITU TREATMENT, AND REUSE
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
3						
Subtotal						$373,357
Contractor Fee (10% of O&M Cost)						$37,336
Legal Fees, Licenses & Permits (5% of O&M Cost)						$18,668
Contingency (25% of O&M Cost)						$93,339
TOTAL						$523,000

PRESENT WORTH COST
ALTERNATIVE 6A: IN SITU TREATMENT - SOIL VAPOR EXTRACTION (SVE)
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$50,000	$50,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	120	$5,000	$600,000
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC excavation not included	ls	1	$5,000	$5,000
Soil Excavation and Loading/Hauling to Treatment Area	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
IN-SITU TREATMENT - SVE				
SVE Pilot Study	ls	1	$200,000	$200,000
SVE Well Installation (20-ft ROI)	wells	365	$500	$182,500
Monitor Well Installation	wells	50	$1,000	$50,000
Geomembrane Soil Cover	sy	44,000	$10	$440,000
SVE (Blower and Off-Gas Treatment) Installation - 20 cfm/well	ls	6	$250,000	$1,500,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENVIRONMENTAL CONTROLS				
Soil Vapor Monitoring (1 event/week)	events	520	$1,500	$780,000
20-hp Blower Power Requirements	yr	10	$70,920	$709,200
Health & Safety Equipment - 10 person team				
Tyvek, gloves, PID, etc.(5 on site personnel)	day/person	12,500	$20	$250,000
Subtotal - Capital Cost				$4,820,700
Contractor Fee (10% of Capital Cost)				$482,070
Legal Fees, Licenses & Permits (5% of Capital Cost)				$241,035
Engineering & Administrative (15% of Capital Cost)				$723,105
Subtotal				$6,266,910
Contingency (25% of Subtotal)				$1,566,728
TOTAL CONSTRUCTION COST				$7,833,638
PRESENT WORTH O&M COST				$1,694,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				$9,528,000

OPERATION AND MAINTENANCE COST
ALTERNATIVE 6A: IN SITU TREATMENT - SOIL VAPOR EXTRACTION (SVE)
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SVE ANNUAL O&M	yr	1	$100,000	$100,000	10	$836,644
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
ENVIRONMENTAL SAMPLING - Included in Groundwater Remedial Options						
Subtotal						$1,210,001
Contractor Fee (10% of O&M Cost)						$121,000
Legal Fees, Licenses & Permits (5% of O&M Cost)						$60,500
Contingency (25% of O&M Cost)						$302,500
TOTAL						$1,694,000

PRESENT WORTH COST
ALTERNATIVE 6B: IN SITU TREATMENT - Thermal Enhanced SVE
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$50,000	$50,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	60	$5,000	$300,000
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC excavation not included	ls	1	$5,000	$5,000
Soil Excavation and Loading/Hauling to Treatment Area	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
IN SITU THERMAL TREATMENT				
Design, Permitting, Reporting	ls	1	$195,000	$195,000
Subsurface Installation	electrodes	1,600	$5,000	$8,000,000
Surface Installation, Start Up	ls	1	$3,000,000	$3,000,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENVIRONMENTAL CONTROLS				
Env. controls for thermal treatment are included in the #'s above				
Air Monitoring	month	24	$3,000	$72,000
Health & Safety Equipment - 5 person team				
Tyvek, gloves, PID, etc. (5 on site personnel)	day/person	5,200	$20	$104,000
Subtotal - Capital Cost				$11,780,000
Contractor Fee (10% of Capital Cost)				$1,178,000
Legal Fees, Licenses & Permits (5% of Capital Cost)				$589,000
Engineering & Administrative (15% of Capital Cost)				$1,767,000
Subtotal				$15,314,000
Contingency (25% of Subtotal)				$3,828,500
TOTAL CONSTRUCTION COST				$19,142,500
PRESENT WORTH O&M COST				$26,319,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$45,462,000**

OPERATION AND MAINTENANCE COST
ALTERNATIVE 6B: IN SITU TREATMENT - Thermal Enhanced SVE
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
IN SITU THERMAL TREATMENT						
Thermal and Post-Thermal Operation	months/yr	12	$750,000	$9,000,000	1.5	$12,951,036
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
ENVIRONMENTAL SAMPLING - Included in Groundwater Remedial Options						
Subtotal						$13,324,393
Electrical Engergy	day	365	$21,000			$7,665,000
Contractor Fee (10% of O&M Cost)						$1,332,439
Legal Fees, Licenses & Permits (5% of O&M Cost)						$666,220
Contingency (25% of O&M Cost)						$3,331,098
TOTAL						$26,319,000

Combination Groundwater and Soil Remedial Alternative Cost Summary

Feasibility Study Report
Former PSC Site - Rock Hill, SC

Alternative	***Description***	***Construction Cost***	***Present Worth O&M Cost***	**Total Present Worth Cost**
1	Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Soil Mixing	$31,988,991	$11,253,000	**$43,242,000**
2	Hydraulic Containment, Select Excavation, SVE, Thermal-Enhanced MPE, and Air Sparging	$15,408,445	$13,552,000	**$28,960,000**
3	Hydraulic Containment, SVE, Thermal-Enhanced MPE, and In Situ Thermal Treatment	$14,604,444	$21,250,000	**$35,854,000**

Notes:
Total present worth costs are rounded to the nearest $1,000.

PRESENT WORTH COST
ALTERNATIVE 1: Hydraulic Containment (regolith and bedrock)**, Select Excavation** (PTSM and metals)**, SVE** (Burn Pit Area)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and Soil Mixing** (as mapped)
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$260,000	$260,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	18	$30,000	$540,000
BUILDING DEMOLITION				
Warehouse Building Demo and Removal	sf	78,000	$2.5	$195,000
Scrap Steel Credit	tons	350	($300)	($105,000)
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC area excavation not included	ls	0	$5,000	$0
Soil Excavation and Loading/Hauling	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
Confirmatory Sampling and Waste Characterization	each	10	$250	$2,500
EXCAVATE PTSM AREAS				
Excavation & Handling of Material	tons	2,500	$10	$25,000
Benching (1:1 slope) excavation	tons	1,860	$10	$18,600
Shoring (areas where benching is infeasible W of warehouse)	sf	3,340	$40	$133,600
Transport & Disposal of Non-Hazardous Material (95%)	tons	4,140	$40	$165,600
Transport & Disposal of Hazardous Material (5%)	tons	220	$350	$77,000
Backfill with Imported Common Fill	tons	4,360	$10	$43,600
Backfill with Clean/Treated Soil	tons	0	$6	$0
Topsoil / Seed	sy	370	$6	$2,220
SVE IN BURN PIT AREA				
SVE Pilot Study	ls	1	$100,000	$100,000
SVE Well Installation (20-ft ROI)	wells	7	$500	$3,500
Monitor Well Installation	wells	5	$1,000	$5,000
Geomembrane Soil Cover	sy	1,000	$10	$10,000
SVE (Blower and Off-Gas Treatment) Installation - 20 cfm/well	ls	1	$125,000	$125,000
DEEP SOIL MIXING				
Pilot Test / Design	ls	1	$100,000	$100,000
Mixing / Construction	tons	250,000	$25	$6,250,000
Potassium Permanganate	tons	2,500	$3,000	$7,500,000
THERMAL-ENHANCED MPE				
Design, Permitting, Reporting	ls	1	$150,000	$150,000
Subsurface Installation	electrodes	200	$7,700	$1,540,000
Surface Installation, Start Up	ls	1	$1,300,000	$1,300,000
REGOLITH (SHALLOW) CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$6,000	$36,000
Extraction System Expansion (controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
BEDROCK CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$12,000	$72,000
Extraction System Expansion (controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
GROUNDWATER TREATMENT SYSTEM UPGRADES - 30 GPM Additional Capacity				
Tank Upgrades	ls	1	$250,000	$250,000
Pump Upgrades	ls	1	$75,000	$75,000
Carbon Adsorption Upgrades	ls	1	$100,000	$100,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENVIRONMENTAL CONTROLS				
Soil Vapor Monitoring (1 event/week)	events	520	$500	$260,000
10-hp Blower Power Requirements (0.75 kW/hp)	hr/yr	8,760	$0.68	$5,913

PRESENT WORTH COST
ALTERNATIVE 1: Hydraulic Containment (regolith and bedrock)**, Select Excavation** (PTSM and metals)**, SVE** (Burn Pit Area)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and Soil Mixing** (as mapped)
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
Sediment & Erosion Controls				
Silt fencing around perimeters and hay bales	ft	1,400	$5	$7,000
Stormwater Collection				
6" pump & hoses	month	1	$2,000	$2,000
Frac tank	month	12	$2,000	$24,000
PTSM Excavation Pit Confirmation Sampling	samples	20	$1,500	$30,000
Air Monitoring				
4 air monitoring stations with MiniRae 3000	month	18	$3,500	$63,000
Health & Safety Equipment - 10 person team				
Tyvek, gloves, PID, etc.	day/person	3,750	$20	$75,000
Waste Characterization (1 every 500 tons)	ea	10	$1,000	$10,000
Subtotal - Capital Cost				$19,685,533
Contractor Fee (10% of Capital Cost)				$1,968,553
Legal Fees, Licenses & Permits (5% of Capital Cost)				$984,277
Engineering & Administrative (15% of Capital Cost)				$2,952,830
Subtotal				$25,591,193
Contingency (25% of Subtotal)				$6,397,798
TOTAL CONSTRUCTION COST				$31,988,991
PRESENT WORTH O&M COST				$11,253,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$43,242,000**

OPERATION AND MAINTENANCE COST
ALTERNATIVE 1: Hydraulic Containment (regolith and bedrock)**, Select Excavation** (PTSM and metals)**, SVE** (Burn Pit Area)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and Soil Mixing** (as mapped)
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SVE ANNUAL O&M	yr	1	$35,000	$35,000	10	$292,825
THERMAL-ENHANCED MPE						
Thermal and Post-Thermal Operation	months/yr	12	$99,500	$1,194,000	1.5	$1,718,171
TREATMENT SYSTEM O&M						
Carbon replacement	events/yr	4	$15,000	$60,000	30	$1,120,070
Additional Power Requirements	kWH/yr	300,000	$0.09	$27,000	30	$504,032
Monthly O&M	events/yr	12	$8,000	$96,000	30	$1,792,113
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$20,000	$4,000	30	$74,671
Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$40,000	$40,000	30	$746,714
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
Subtotal						$6,995,309
Electrical Energy	day	365	$4,000			$1,460,000
Contractor Fee (10% of O&M Cost)						$699,531
Legal Fees, Licenses & Permits (5% of O&M Cost)						$349,765
Contingency (25% of O&M Cost)						$1,748,827
TOTAL						$11,253,000

PRESENT WORTH COST
ALTERNATIVE 2: Hydraulic Containment (bedrock)**, Select Excavation** (PTSM and metals)**, SVE** (as mapped)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and Air Sparging** (as mapped)
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$25,000	$25,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	18	$20,000	$360,000
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC area excavation not included	ls	0	$5,000	$0
Soil Excavation and Loading/Hauling	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
Confirmatory Sampling and Waste Characterization	each	10	$250	$2,500
EXCAVATE PTSM AREAS				
Excavation & Handling of Material	tons	2,500	$10	$25,000
Benching (1:1 slope) excavation	tons	1,860	$10	$18,600
Shoring (areas where benching is infeasible W of warehouse)	sf	3,340	$40	$133,600
Transport & Disposal of Non-Hazardous Material (95%)	tons	4,140	$40	$165,600
Transport & Disposal of Hazardous Material (5%)	tons	220	$350	$77,000
Backfill with Imported Common Fill	tons	4,360	$10	$43,600
Backfill with Clean/Treated Soil	tons		$6	$0
Topsoil / Seed	sy	370	$6	$2,220
IN-SITU TREATMENT - SVE				
SVE Well Installation (30-ft radius)	wells	140	$500	$70,000
Monitor Well Installation	wells	50	$1,000	$50,000
Geomembrane Soil Cover	sy	44,000	$10	$440,000
SVE (Blower and Off-Gas Treatment) Installation - 20 cfm/well	ls	3	$250,000	$750,000
IN-SITU TREATMENT - AIR SPARGING				
Air Sparging Pilot Study	ls	1	$100,000	$100,000
Air Sparging Injection Well Installation (15-ft ROI)	wells	560	$2,000	$1,120,000
Air Sparging System Installation - 10 cfm/well	treat. area	10	$150,000	$1,500,000
BEDROCK CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$12,000	$72,000
Extraction System Expansion controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
THERMAL-ENHANCED MPE				
Design, Permitting, Reporting	ls	1	$150,000	$150,000
Subsurface Installation	electrodes	200	$7,700	$1,540,000
Surface Installation, Start Up	ls	1	$1,300,000	$1,300,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENVIRONMENTAL CONTROLS				
Soil Vapor Monitoring (1 event/week)	events	520	$1,500	$780,000
10-hp Compressor Power Requirements (0.75 kW/hp)	yr	1	$59,000	$59,000
20-hp Blower Power Requirements	yr	10	$34,500	$345,000
Sediment & Erosion Controls				
Silt fencing around perimeters and hay bales	ft	1,000	$5	$5,000
Stormwater Collection				
6" pump & hoses	month	1	$2,000	$2,000
Frac tank	month	12	$2,000	$24,000
PTSM Excavation Pit Confirmation Sampling	samples	20	$1,500	$30,000
Air Monitoring				
4 air monitoring stations with MiniRae 3000	month	18	$3,500	$63,000

PRESENT WORTH COST

ALTERNATIVE 2: Hydraulic Containment (bedrock)**, Select Excavation** (PTSM and metals)**, SVE** (as mapped)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and Air Sparging** (as mapped)

FEASIBILITY STUDY

PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
Health & Safety Equipment - 10 person team				
Tyvek, gloves, PID, etc.	day/person	3,750	$20	$75,000
Waste Characterization (1 every 500 tons)	ea	10	$1,000	$10,000
Subtotal - Capital Cost				$9,482,120
Contractor Fee (10% of Capital Cost)				$948,212
Legal Fees, Licenses & Permits (5% of Capital Cost)				$474,106
Engineering & Administrative (15% of Capital Cost)				$1,422,318
Subtotal				$12,326,756
Contingency (25% of Subtotal)				$3,081,689
TOTAL CONSTRUCTION COST				$15,408,445
PRESENT WORTH O&M COST				$13,552,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$28,960,000**

OPERATION AND MAINTENANCE COST

ALTERNATIVE 2: Hydraulic Containment (bedrock)**, Select Excavation** (PTSM and metals)**, SVE** (as mapped)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and Air Sparging** (as mapped)

FEASIBILITY STUDY

PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%

Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
ENV. MONITORING OF SVE and AIR SPARGE SYSTEM						
Air Sampling and Analysis	events/yr	12	$2,000	$24,000	10	$200,795
Groundwater Sampling and Analysis	events/yr	12	$5,000	$60,000	10	$501,986
Air Sparging System O&M	yr	1	$100,000	$100,000	10	$836,644
20-hp Blower Power Requirements (0.75 kW/hp)	yr	1	$35,400	$35,400	10	$296,172
10-hp Compressor Power Requirements (0.75 kW/hp)	yr	1	$11,800	$11,800	10	$98,724
Off-Gas Treatment	Included in air sparging system installation costs					
THERMAL-ENHANCED MPE						
Thermal and Post-Thermal Operation	months/yr	12	$99,500	$1,194,000	1.5	$1,718,171
TREATMENT SYSTEM O&M						
Carbon replacement	events/yr	4	$15,000	$60,000	30	$1,120,070
Additional Power Requirements	kWH/yr	300,000	$0.09	$27,000	30	$504,032
Monthly O&M	events/yr	12	$8,000	$96,000	30	$1,792,113
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$20,000	$4,000	30	$74,671
Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$40,000	$40,000	30	$746,714
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
Subtotal						$8,636,805
Electrical Energy	day	365	$4,000			$1,460,000
Contractor Fee (10% of O&M Cost)						$863,681
Legal Fees, Licenses & Permits (5% of O&M Cost)						$431,840
Contingency (25% of O&M Cost)						$2,159,201
TOTAL						$13,552,000

PRESENT WORTH COST
ALTERNATIVE 3: Hydraulic Containment (regolith and bedrock)**, SVE** (Burn Pit Area)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and In Situ Thermal Treatment** (as mapped)
FEASIBILITY STUDY
PSC SITE

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL COST (DOLLARS)
MOBILIZATION	ls	1	$25,000	$25,000
CONTRACTOR GENERAL CONDITIONS (CM, Superintendant, Trailer, Power, Telephone, Water, etc.)	month	18	$20,000	$360,000
EXCAVATE METALS EXCEEDANCE AREAS				
Mobilization - Required when VOC area excavation not included	ls	1	$5,000	$5,000
Soil Excavation and Loading/Hauling	tons	56	$10	$556
Transport & Disposal of VOC-Hazardous Soil (0%)	tons	0	$350	$0
Transport & Disposal of Non-Hazardous Material (100%)	tons	56	$40	$2,222
Backfill with Imported Common Fill	tons	56	$10	$556
Topsoil / Seed	sy	111	$6	$667
Confirmatory Sampling and Waste Characterization	each	10	$250	$2,500
SVE IN BURN PIT AREA				
SVE Pilot Study	ls	1	$100,000	$100,000
SVE Well Installation (20-ft ROI)	wells	7	$500	$3,500
Monitor Well Installation	wells	5	$1,000	$5,000
Geomembrane Soil Cover	sy	1,000	$10	$10,000
SVE (Blower and Off-Gas Treatment) Installation - 20 cfm/well	ls	1	$125,000	$125,000
THERMAL-ENHANCED MPE & IN SITU THERMAL				
Design, Permitting, Reporting	ls	1	$195,000	$195,000
Subsurface Installation	electrodes	755	$7,200	$5,436,000
Surface Installation, Start Up	ls	1	$1,532,250	$1,532,250
REGOLITH (SHALLOW) CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	4	$6,000	$24,000
Extraction System Expansion (controls, pumps, conduits, etc.)	each	4	$15,000	$60,000
BEDROCK CONTAINMENT SYSTEM				
Extraction Wells (3-5 GPM per well)	each	6	$12,000	$72,000
Extraction System Expansion controls, pumps, conduits, etc.)	each	6	$15,000	$90,000
GROUNDWATER TREATMENT SYSTEM UPGRADES - 30 GPM Additional Capacity				
Tank Upgrades	ls	1	$250,000	$250,000
Pump Upgrades	ls	1	$75,000	$75,000
Carbon Adsorption Upgrades	ls	1	$100,000	$100,000
IMPLEMENT DEED RESTRICTIONS (Excludes Property Purchase)	each	1	$50,000	$50,000
ENVIRONMENTAL CONTROLS				
Soil Vapor Monitoring (1 event/week)	events	520	$500	$260,000
10-hp Blower Power Requirements	yr	10	$5,910	$59,100
Sediment & Erosion Controls				
Silt fencing around perimeters and hay bales	ft	1,000	$5	$5,000
Air Monitoring				
4 air monitoring stations with MiniRae 3000	month	18	$3,500	$63,000
Health & Safety Equipment - 10 person team				
Tyvek, gloves, PID, etc.	day/person	3,750	$20	$75,000
Waste Characterization (1 every 500 tons)	ea	1	$1,000	$1,000
Subtotal - Capital Cost				$8,987,350
Contractor Fee (10% of Capital Cost)				$898,735
Legal Fees, Licenses & Permits (5% of Capital Cost)				$449,368
Engineering & Administrative (15% of Capital Cost)				$1,348,103
Subtotal				$11,683,555
Contingency (25% of Subtotal)				$2,920,889
TOTAL CONSTRUCTION COST				$14,604,444
PRESENT WORTH O&M COST				$21,250,000
TOTAL PRESENT WORTH COST (ROUNDED TO NEAREST THOUSAND)				**$35,854,000**

OPERATION AND MAINTENANCE COST
ALTERNATIVE 3: Hydraulic Containment (regolith and bedrock)**, SVE** (Burn Pit Area)**, Thermal-Enhanced MPE** (Fuel Oil Area)**, and In Situ Thermal Treatment** (as mapped)
FEASIBILITY STUDY
PSC SITE

Inflation Rate: 3.5% Real Discount Rate: 3.4%
Nominal Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE (DOLLARS)	TOTAL ANNUAL COST (DOLLARS)	OPERATION TIME (YEARS)	PRESENT WORTH
SVE ANNUAL O&M	yr	1	$35,000	$35,000	10	$292,825
THERMAL-ENHANCED MPE						
Thermal and Post-Thermal Operation	months/yr	12	$356,000	$4,272,000	1.5	$6,147,425
TREATMENT SYSTEM O&M						
Carbon replacement	events/yr	4	$15,000	$60,000	30	$1,120,070
Additional Power Requirements	kWH/yr	300,000	$0.09	$27,000	30	$504,032
Monthly O&M	events/yr	12	$8,000	$96,000	30	$1,792,113
ENV. MONITORING OF GROUNDWATER & SURFACE WATER						
Site Monitoring Plan & Reevaluation (every 5 years)	lump sum	1	$20,000	$4,000	30	$74,671
Environmental Sampling/Analysis/Assessment (yearly)	lump sum	1	$40,000	$40,000	30	$746,714
Report Preparation (yearly)	lump sum	1	$20,000	$20,000	30	$373,357
SITE INSPECTIONS & MAINTENANCE						
Deed Restriction Compliance Audit	events/yr	1	$5,000	$5,000	30	$93,339
Property Inspection / Management	events/yr	1	$5,000	$5,000	30	$93,339
Mowing	events/yr	12	$500	$6,000	30	$112,007
Fence Maintenance	events/yr	1	$4,000	$4,000	30	$74,671
Subtotal						$11,424,564
Electrical Energy	day	365	$14,400			$5,256,000
Contractor Fee (10% of O&M Cost)						$1,142,456
Legal Fees, Licenses & Permits (5% of O&M Cost)						$571,228
Contingency (25% of O&M Cost)						$2,856,141
TOTAL						$21,250,000

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