ALCOA INC.
2300 North Wright Rd.
Alcoa TN, 37701

RECEIVED

February 27, 2009

Chief, New York Remediation Branch
Attention: Mr. Michael A. Walters, Superfund Site Remedial Project Manager
Emergency and Remedial Response Division
U.S. Environmental Protection Agency, Region II
290 Broadway, 20th Floor
New York, New York 10007-1866

**CERTIFIED MAIL – 7007 0710 0003 2300 2646**

**Re: Submittal of Focused Feasibility Study - Part I: Development and Screening of Remedial Technologies for the Alcas Property at the Olean Superfund Site, Cattaragus County, New York.**

Dear Mr. Walters:

Enclosed is Part I of the Focused Feasibility Study, which documents the Development and Screening of Remedial Technologies for to the Alcas Property at the Olean Superfund Site, Cattaraugus County, New York U.S.

The purpose of this document is to present the initial step in identifying potential remedies for at the Alcas site that meet the remedial action objectives and that are within the constraints and stipulations outlined in Alcoa's November 14, 2008 letter with subsequently approval by USEPA in their letter dated January 16, 2009. The remedial alternatives addressed in this report have the potential to meet the main Remedial Action Objectives identified for this site which are to minimize the migration of COCs from the site to the City Aquifer and address the dissolved phase plume that has migrated to the south of the site.

Based on the findings of this initial evaluation, subsequent steps in this process will further refine the alternatives, identify additional data needs (i.e., modeling, pump tests, treatability studies, pilot tests, etc...), and develop detailed costs estimates. The results from these steps will lead up to the final, detailed analysis of alternatives and ultimately to the selection and implementation of a remedy(s).

Should you have any questions or comments concerning this document, please call Timothy White at 281-493-9005 or me at 865-977-3811.

Sincerely,

Timothy H. White
for

Robert A. Prezbindowski
Alcoa Remediation

cc: Mr. Michael Walters – US EPA, Region II (3 copies)
Mr. Vivek Nattanmai – NYDEC (4 electronic copies) (Certified Mail – 7007 0710 0003 2300 2653)
Mr. Eric W. Wohlers - Cattaraugus County Health Department
Mr. Carey Litteer – Cutco Corp.

# FOCUSED FEASABILITY STUDY

## Part I: Development and Screening of Remedial Technologies

**FOR THE**

**ALCAS CUTLERY CORPORATION FACILITY SITE**
**OLEAN, NEW YORK**

**Prepared for**

**ALCOA, Inc.**
**Alcoa, Tennessee**

**February 27, 2009**

**Prepared by**

ENI Engineering, LLC
Houston, Texas

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# 1.0 Introduction

Purpose of this document is to present the initial step in identifying potential remedies for at the Alcas site that meet the remedial action objectives and that are within the constraints and stipulations outlined in Alcoa's November 14, 2008 letter with subsequently approval by USEPA in their letter dated January 16, 2009. The remedial alternatives addressed in this report have the potential to meet the main Remedial Action Objectives ("RAOs") identified for this site which are to minimize the migration of COCs from the site to the City Aquifer and address the dissolved phase plume that has migrated to the south of the site.

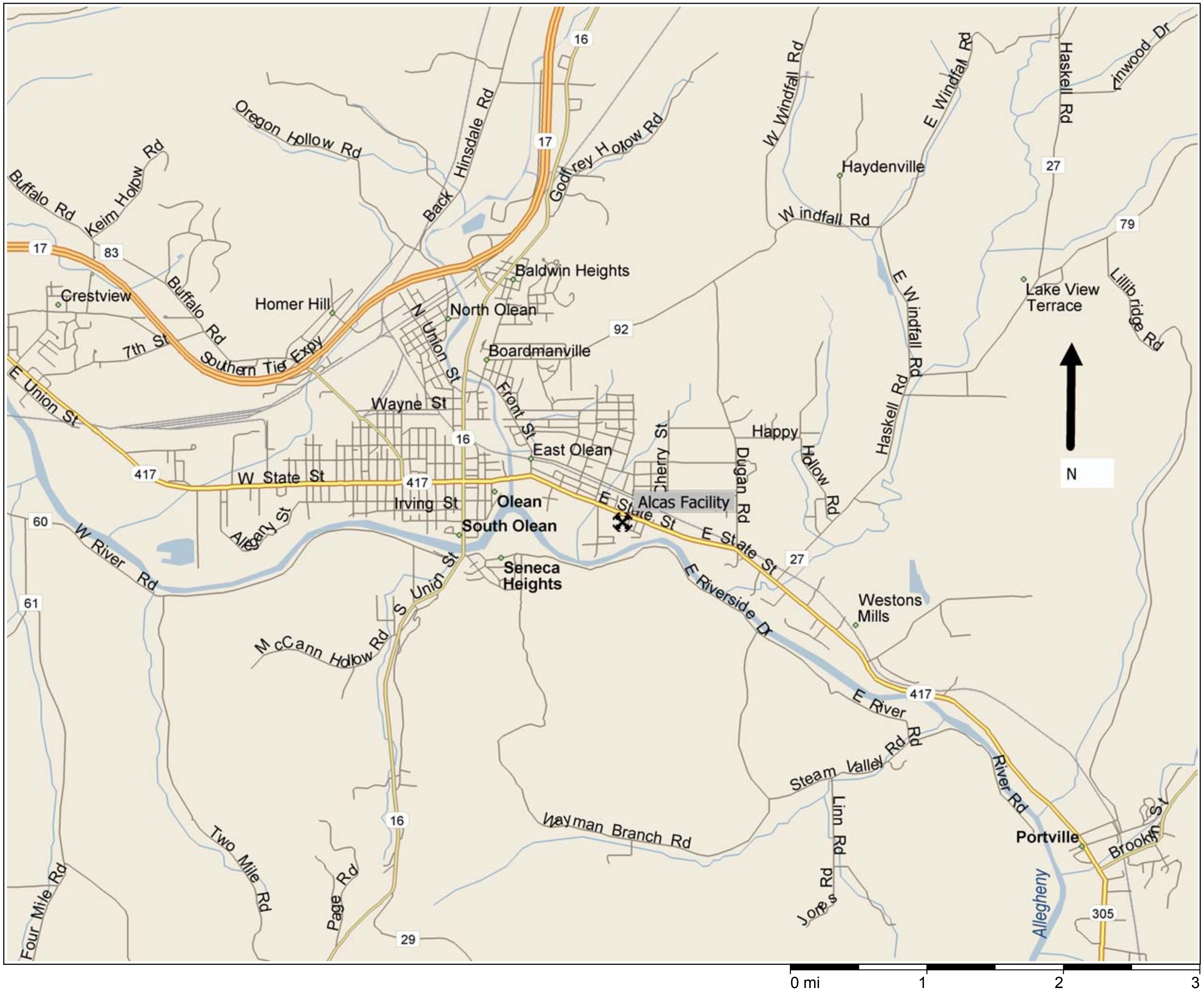
Based on the findings of this initial evaluation, subsequent steps in this process will further refine the alternatives, identify additional data needs (i.e., modeling, pump tests, treatability studies, pilot tests, etc…), and develop detailed costs estimates. The results from these steps will lead up to the final, detailed analysis of alternatives and ultimately to the selection and implementation of a remedy(s).

## 1.1 *Site History*

The Olean Well Field Superfund Site (the *"Superfund Site"*) is located in the eastern portion of the City of Olean ("*City*") and west and northwest of the Towns of Olean and Portville in Cattaraugus County, New York as shown in Figure 1-1. The Superfund Site incorporates three municipal wells (*hereinafter referred to as the "City Production Wells"*), and spans approximately 800 acres of property principally occupied by industrial facilities. The Allegheny River flows through the southwest and southern portions of the Superfund Site. State Routes 16 and 417 provide access to the area. A portion of the Superfund Site is currently occupied by the Alcas/Cutco Cutlery Corporation facility (*hereinafter referred to as "Alcas" or the "Site"*), which has manufactured cutlery and sporting knives at the Site since 1949. As part of the manufacturing process, the facility formerly used trichloroethene ("*TCE*") in on site vapor degreasers.

Following initial investigation activities, the U.S. Environmental Protection Agency ("*EPA*") added the Superfund Site to the National Priorities List in September 1983. Between 1983 and 1985, the EPA conducted additional investigations at the Superfund Site and initiated early remedial actions including the supply of carbon adsorption filters to owners of impacted private wells. It was determined that soils and groundwater were impacted by several chemicals of concern ("*COCs*") including TCE and its degradation products, with established pathways of migration to the Superfund Site's Upper Aquifer (*hereinafter referred to as the "Upper Aquitard or UA"*) and Lower Aquifer (*hereinafter referred to as the "City Aquifer*"). Targeted daughter, or degradation, products for TCE include cis-1,2-dichloroethene ("*cDCE*") and vinyl chloride ("*VC*"). Tetrachloroethene ("*PCE*"), a parent product for TCE, has also been detected at the Site and is most likely derived from a commercial grade fraction of the TCE solvent.

Figure 1-1



Oregon Hollow Rd
Hinsdale Rd
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Buffalo Rd
Keim Holow Rd
Godfrey Holow Rd
W Windfall Rd
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Haskell Rd
Linwood Dr
Haydenville
W indfall Rd
Baldwin Heights
Crestview
Homer Hill
North Olean
Buffalo Rd
7th St
Southern Tier Expy
N Union St
Boardmanville
E W indfall Rd
Lake View Terrace
Lillibridge Rd
E Union St
Wayne St
Front St
Happy
Haskell Rd
Cherry St
Dugan Rd
Hollow Rd
East Olean
W State St
Irving St
Olean
E State St
Alcas Facility
South Olean
W River Rd
Allegany St
E State St
Seneca Heights
S Union St
E Riverside Dr
Westons Mills
McCann Hollow Rd
E River Rd
Steam Valley Rd
River Rd
Wayman Branch Rd
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Linn Rd
Portville
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When released into the environment, chlorinated organic solvents that are heavier than water are commonly referred to as dense nonaqueous phase liquids or DNAPLs. Because they are heavier than water, DNAPLs can readily migrate downward and through groundwater deep into the subsurface. DNAPL can exist in the subsurface as free-phase and residual DNAPL. When released, free-phase DNAPL will move downward through the subsurface under the force of gravity or laterally along the surface of sloping fine-grained soil units. Point release types of equal mass, will typically travel much deeper than release types that are spread over greater surface areas. Free-phased DNAPLs will distribute in the subsurface as both disconnected blobs and ganglia of liquid referred to as "residual", and in larger accumulations referred to as "pools." The portion of the subsurface where DNAPLs are located, either free or residual, is commonly referred to as the DNAPL zone. The DNAPL zone is that portion of the subsurface where the released immiscible liquids (via free-phase DNAPL migration and chemical diffusion) are present within the subsurface media.

The trailing end of migrating DNAPL being trapped in pore spaces or fractures by capillary forces forms residual DNAPL. The amount of residual DNAPL contained in the subsurface is a function of the DNAPL's density, viscosity, and interfacial tension and the geologic characteristics of the site such as, soil pore size, permeability, capillary pressure, root holes, small fractures, and slickensides found in silt, clay layers, etc.. The subsurface DNAPL distribution is typically impossible to locate or delineate accurately. DNAPL migrates preferentially through selected pathways and is affected by small-scale changes in the stratigraphy. Therefore, the ultimate path taken by DNAPL can be very difficult to characterize and predict. Beneath the Main Building at this site, only residual DNAPL is present.

## 1.2 *Site Geology*

At the Site, different lithologic units have been identified. The lowest geologic unit encountered at this site is the glacio-lacustrine clays, situated below the glacial outwash unit at approximately 82 to 97 feet below land surface ("*bls*"). The glacial outwash was encountered from approximately 25 to 35 feet bls, and where encountered, varies in thickness across the Site between 54 and 72 feet. This unit is very permeable, and yields significant quantities of water. The City Aquifer hydrogeologic unit is primarily contained within the glacial outwash geologic unit at the Site.

The overlying glacial till unit was encountered at approximately 0 to 12 feet bls, and varies in thickness across a majority of the Site between 16 and 29 feet. The overlying till unit was identified by its olive gray color and/or the gravel content and is commonly referred to as the Upper Aquitard. This unit contained 50 to 97 percent clay based on the historical sieve analyses. The thickness of this unit is highly variable across the Site. Within this unit a discontinuous thicker and coarser sequence of sediments may provide a preferential pathway for water and constituent migration and is referred to in this document as the Upper Water Bearing Zone. Figure 1-2 is a simplified depiction of the geological units at the site.

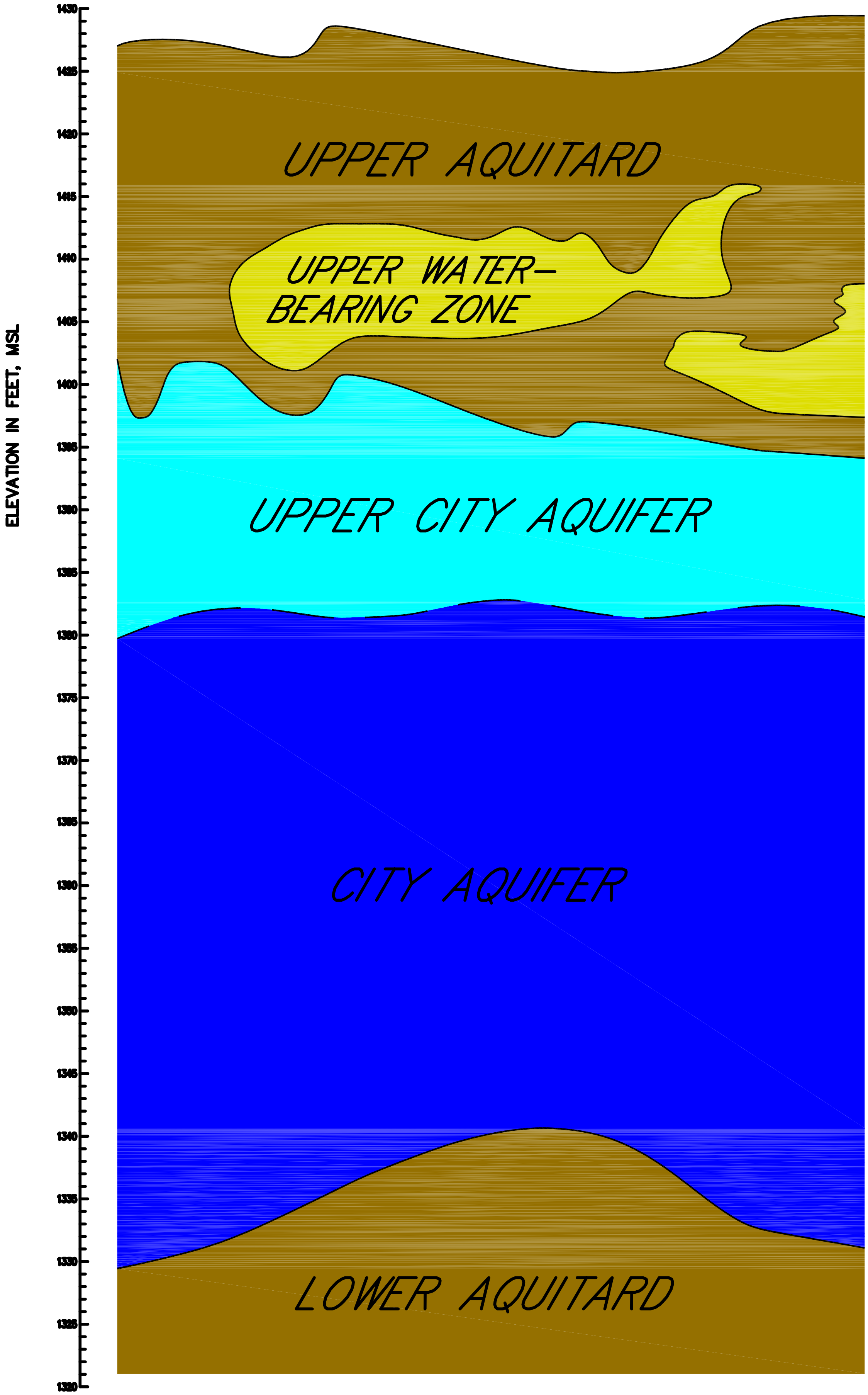


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FIGURE 1–2

SITE LITHOLOGY
ALCAS FACILITY
OLEAN, NEW YORK

| DRAWN BY: | DATE: | PROJ. NO. |
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## 1.3 *Site Hydrogeology*

The water level elevations for the upper and lower portions of the City Aquifer wells were contoured. Figures 1-3 shows the upper City Aquifer contours. The contours for both sets of wells show groundwater generally flowing to the east toward City Production Well 18M. These maps show that City Production Well 18M's controlling influence potentially extends beyond the westward boundary of the Main Building, thus capturing affected groundwater in the City Aquifer.

The water-level elevations in the upper and lower portions of the City Aquifer were compared to each other to determine if the pumping from the lower portion of the City Aquifer created vertical gradients within the City Aquifer. Personal communication with City personnel indicated that City Production Well 18M is screened in the lower portion of the City Aquifer.

Based on these water levels, groundwater flow in the City Aquifer appears consistent and uniform. This was expected since City Production Well 18M has been in continuous service since 1990. Given City Production Well 18M has been pumping for the last 15 years and the consistent and uniform surrounding groundwater flow, the flow system in the City Aquifer has most likely reached steady state. This means that the shape of the contours and complete capture of affected groundwater in the City Aquifer will not change unless the pumping in City Production Well 18M is reduced or stopped.

The water-level elevations for the UA are shown in Figure 1-4. In general, ground water flow is to the east toward City Production Well 18M. Previous contour maps have shown a component of flow in the UA toward the river. The flow toward the river occurred about half way between the Main Building and the river in the vicinity of RU-10.

Several anomalies exist in the UA water levels. The water level lows at RU-3 and RU-15 and the high at RU-8 are likely to be the result of erroneous measurements caused by the small-diameter casing (¾-inch) of those wells. The water level high at RU-13 has been observed since this well was installed.

Surveying data for well casing elevations was verified as correct. The mounding effect seen in the area of RU-13 has not been determined. The issue of a possible leak from a water line was discussed with the City of Olean. The City of Olean believes that a small leak of this size does not warrant exploratory excavations in the area.

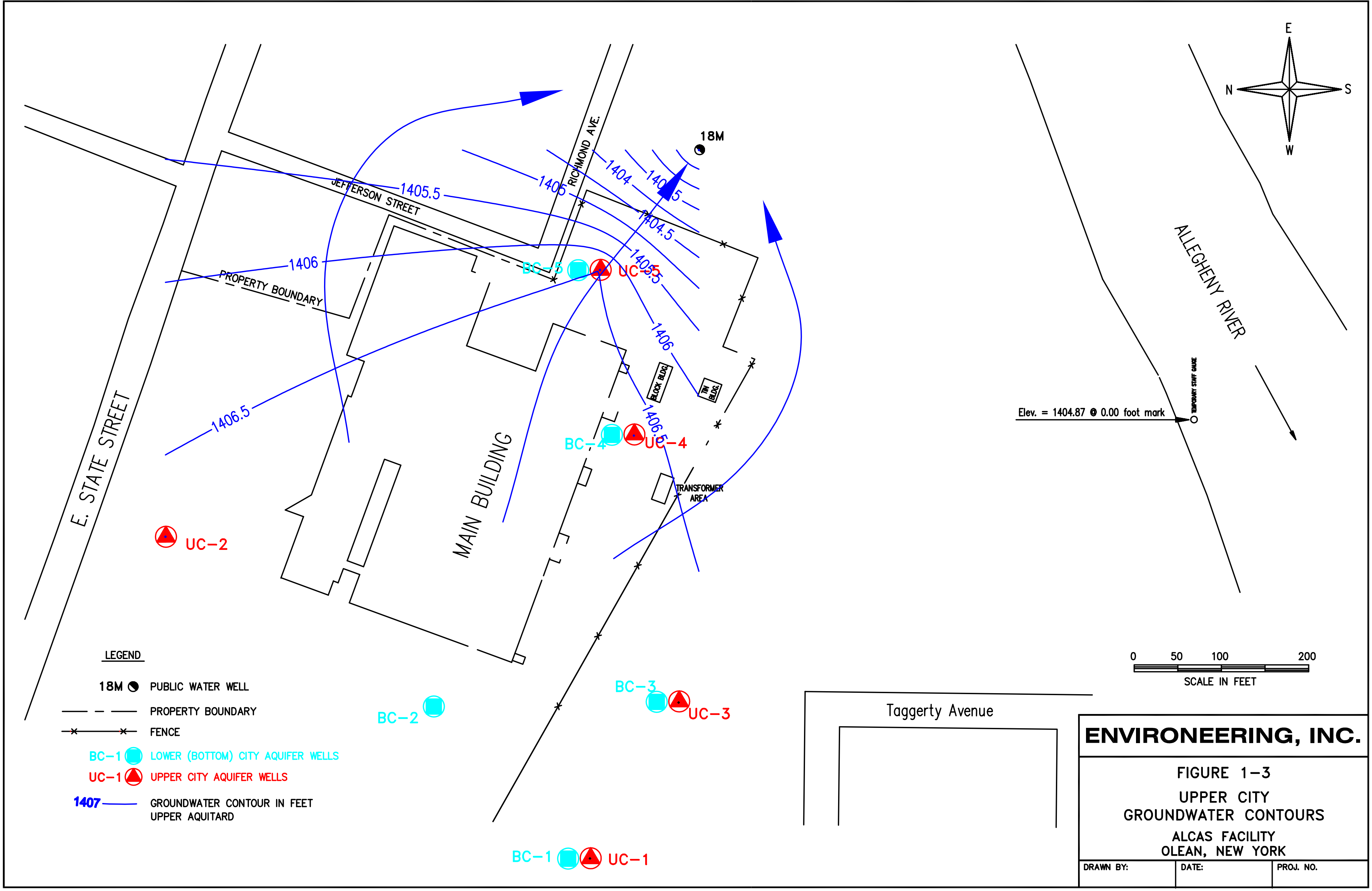


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FIGURE 1-3
UPPER CITY
GROUNDWATER CONTOURS
ALCAS FACILITY
OLEAN, NEW YORK

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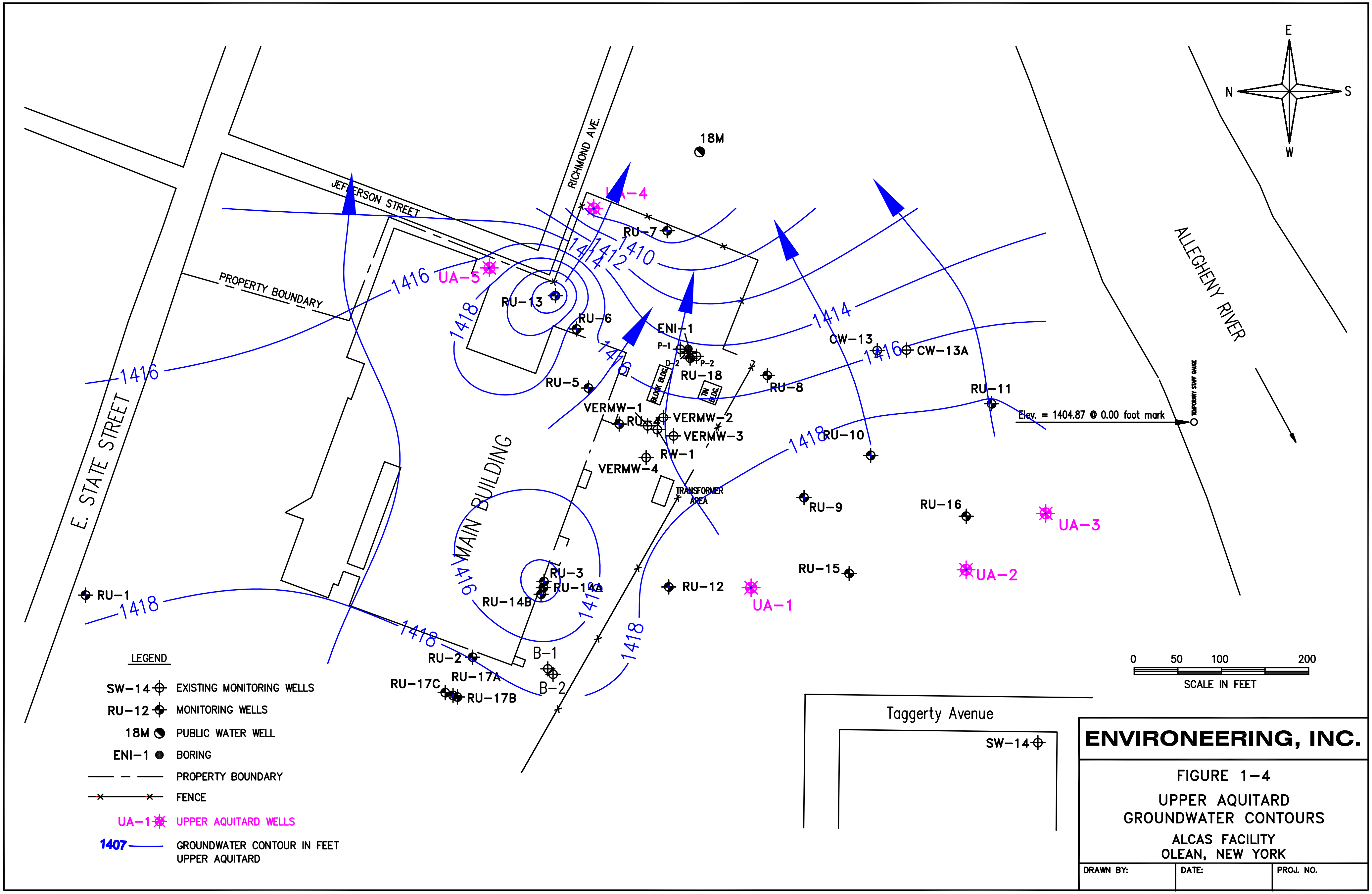


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FIGURE 1-4

UPPER AQUITARD GROUNDWATER CONTOURS

ALCAS FACILITY
OLEAN, NEW YORK

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## 1.4 *Soil/DNAPL Assessment Summary*

Early investigations at the site involved the collection of soil samples from the southern/southeast portion of the site. However, the concentrations in the soil samples do not indicate residual DNAPL in this portion of the site. It is possible that some of the affected soils may be associated with small, nearby releases (*i.e.*, weed killing activities).

The majority of impacted soils at the Site are beneath the Main Building. Varying concentrations of COCs were detected in the soil samples collected from the borings installed within the Main Building. Most of the low concentrations of COCs identified are likely associated with the migration of gaseous vapors through the subsurface. However, concentrations of TCE as high as 280 milligrams per kilogram (mg/kg) were detected in boring B-3 at 9-10 feet depth.

This concentration represents the highest soil sample concentration of TCE detected at the site to date. The presence of this concentration of TCE beneath the building further substantiates the hypothesis that the DNAPL source area is under the building.

## 1.5 *Groundwater Assessment Summary*

In 2004, vertical profiling of the groundwater at the site was conducted. Groundwater samples were collected at 10 foot intervals from two borings at depths ranging from approximately 30 feet to approximately 100 feet below grade.

Of the COCs at the site, TCE and PCE were the most prevalent. The profile data shows the TCE as a continuous release into the City Aquifer coinciding with the bulk of the solvent migrating vertically from beneath the building through the UA then traveling horizontally. Profiling samples from the bottom of the City Aquifer provide a characterization of water quality and determine that no free DNAPL existed at the bottom of this unit. Results suggest that the source of the material impacting 18M originates as a residual DNAPL in the Upper Aquitard not as a "pooled DNAPL" in the City Aquifer.

### *1.5.1* Upper Water Bearing Zone

The sampling results show several key components of the plume distribution at the Alcas facility. The wells around the southeast corner of the building (RU-4, RU-5, and RU-6) have TCE concentrations that exceed 1 percent of the solubility of TCE in water (solubility limit). This indicates that at or up gradient of this location is a DNAPL source. This places the likely source of DNAPL under the building. Figure 1-5 illustrates the TCE in the Upper Water Bearing Zone.

The dissolved-phase plume extends from the southeast corner toward the river generally to the south. This direction of contaminant migration resulted from the periods before Well 18M was installed and during the shutdown of 18M during the 1970s. During the 1960s and post 1980, a portion of the groundwater flow is toward 18M. The portion of the site that has flow toward

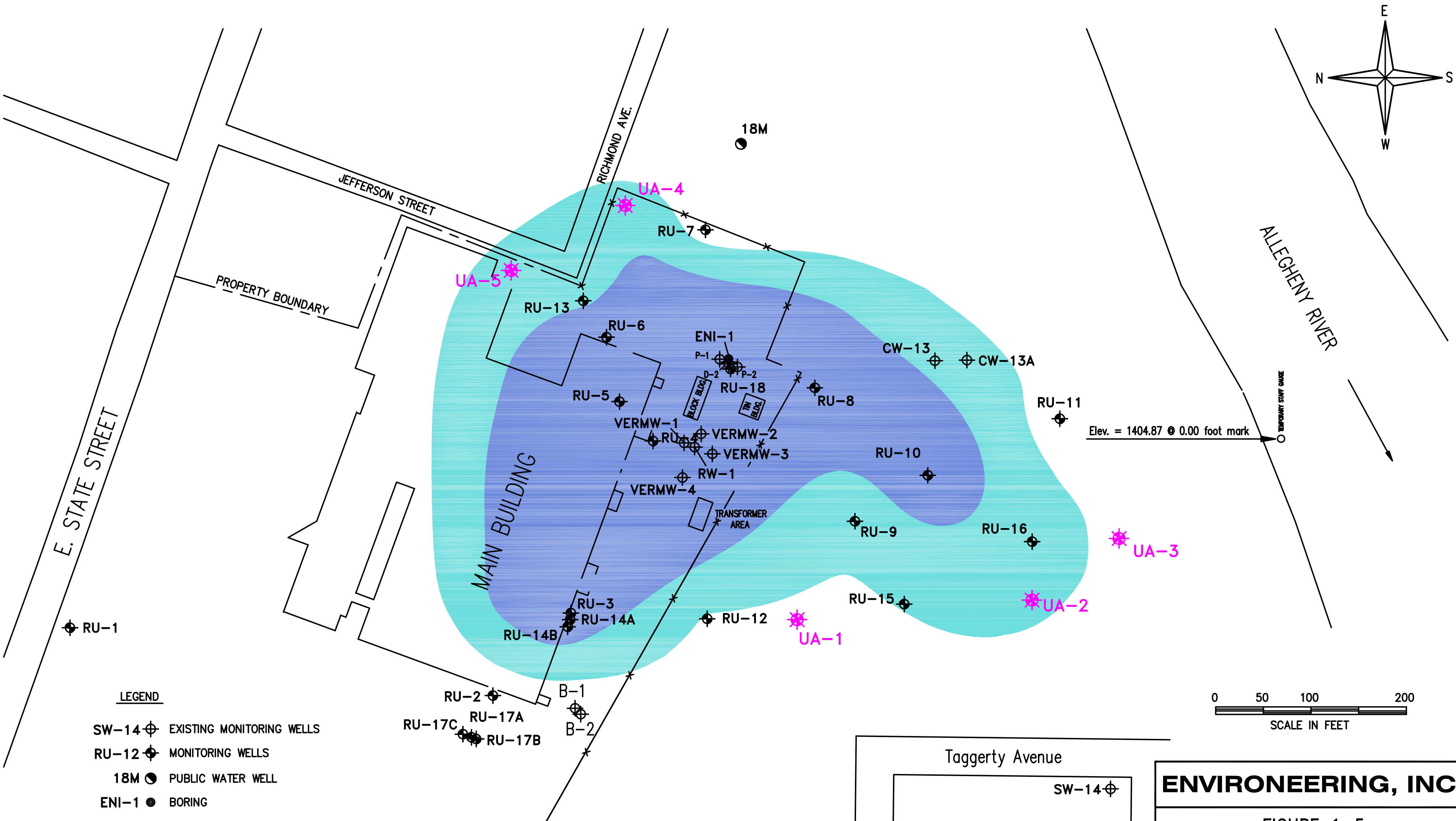
18M in the Upper Water Bearing Zone is from under the eastern half of the building and between RU-8 and RU-10. The groundwater concentrations are decreasing from the building toward the east with TCE concentrations in RU-8 and RU-10 at 0.0059 mg/L and 0.300 mg/L, respectively. Closer to the river, the TCE concentration increases to 2.80 mg/L in RU-10. This higher concentration in RU-10 represents the migration of TCE prior to the installation of the 18M and during the shutdown of 18M during the 1970s. Once 18M was restarted, the TCE in the vicinity of RU-10 was outside the capture zone of 18M. Lower concentrations of TCE near RU-8 are a result of the continuous pumping of 18M since 1980.

### *1.5.2* City Aquifer

The top of the City Aquifer is generally located 25 to 35 feet below grade in the western portion of the Site, dipping to the east and south. To assist in the assessment of groundwater quality in the upper portion of the City Aquifer, five monitor wells (UC-1 through UC-5) were installed on the Alcas property. To assess groundwater quality in the lower portion of the City Aquifer, five monitor wells (BC-1 through BC-5) were installed on the Alcas property. In addition, monitor wells D-2, CW-13, B-2, RU-17C, RU-18 and UC-1 through UC-5 have been used to assess the impact to the upper portion of the City Aquifer.

City well 18M is located east of the Alcas facility. Currently, TCE concentrations in 18M are approximately 0.020 mg/L. The highest concentration of TCE (10-16 mg/L) has been found in D2. Monitor wells UC-1 – UC4 contain TCE concentrations ranging from 0.010 mg/L to 0.025 mg/L. Figure 1-6 illustrates the TCE concentrations of the upper city aquifer. In the lower portion of the City Aquifer no detectable concentrations of TCE above the drinking water standard have been observed.

In 1991, the EPA issued unilateral administrative order OU1 to the PRPs. As part of the OU1 order, EPA required groundwater samples be collected from selected wells around the Olean Well Field on a quarterly and semi-annual basis. Alcas D-2 and CW-13 are the two closest wells to the Alcas facility. D-2 has a concentration of approximately 13 mg/L, and CW-13 has a concentration of approximately 0.0098 mg/L. The concentration of TCE in these wells has remained relatively unchanged for the past 15 years, indicating that while 18M is in operation, a stable plume exists in the City Aquifer.




LEGEND

- SW-14 EXISTING MONITORING WELLS
- RU-12 MONITORING WELLS
- 18M PUBLIC WATER WELL
- ENI-1 BORING
- PROPERTY BOUNDARY
- FENCE
- UA-1 UPPER AQUITARD WELLS

APPROXIMATE AREA GREATER THAN 100 PPB TCE IN GROUNDWATER SAMPLES

APPROXIMATE AREA GREATER THAN 5 PPB AND LESS THAN 100 PPB TCE IN GROUNDWATER SAMPLES

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FIGURE 1-5

UPPER AQUITARD GROUNDWATER CONDITIONS

ALCAS FACILITY
OLEAN, NEW YORK

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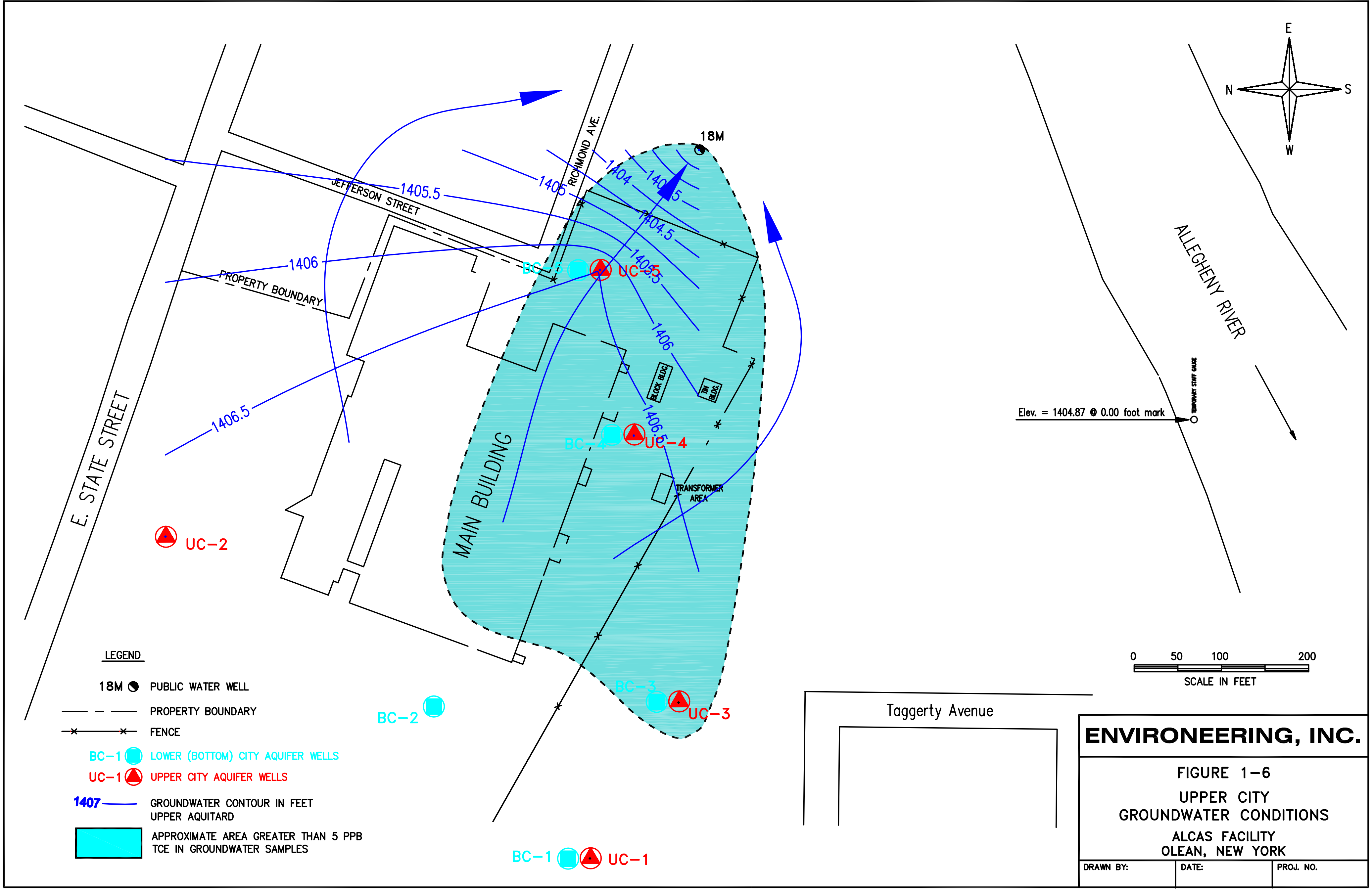


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FIGURE 1-6
UPPER CITY
GROUNDWATER CONDITIONS
ALCAS FACILITY
OLEAN, NEW YORK

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## 1.6 *Site Conceptual Model*

Decisions regarding the effectiveness of remedial actions must be based on a thorough understanding of the physical and chemical conditions of a site. The conceptual model serves as a method of evaluating the restoration potential of a site, relating governing parameters to site-specific data. The conceptual model can be summarized as follows:

- The source material is composed of residual chlorinated solvents which behave as DNAPL in the subsurface;
- At the Alcas site, The Upper Water Bearing Unit is a discontinuous unit comprised of predominantly of sand, primarily appearing as localized stream deposits and fill material;
- The Upper Aquitard is a very heterogeneous unit comprised of predominantly silty/clayey units with intermixed sandy units characterized by low permeabilities, thereby acting as an aquitard overlying the City Aquifer;
- Horizontal groundwater flow is the primary component of groundwater flow, and vertical groundwater flow is a secondary component;
- At the Site, horizontal flow of groundwater in the Upper Aquifer is generally directed to the south toward the Allegheny River when the City Production Wells are not active;
- The governing source areas on the Alcas Property are DNAPL zones which generate plume zones consisting of dissolved and vapor phase derivatives that transport through the soil media;
- The primary source area consisting of one or more entry zones and associated DNAPL zones is located below the Main Building;
- Other, more minor, entry zones may also be present south of the Main Building; and
- Dissolved phase concentrations in the Upper Aquifer south of the Main Building are indicative of a plume zone migrating downgradient of a source area under the Main Building when 18m was not pumping.

This information suggests a probable DNAPL zone under the Main Building that will persist and continue to generate dissolved phase derivatives for unknown lengths of time as long as the source DNAPL persists. Overall, the DNAPL zones proposed by the updated conceptual model include a significantly larger area than originally specified in the OU2 ROD.

# 2.0 Objectives and Constraints

The remedial alternatives addressed is this report have the potential to meet the Remedial Action Objections outlined in this document. In identifying and screening of those technologies, Remedial Action Objectives and applicable or relevant and appropriate requirements (ARARs) were established.

## 2.1 *Remedial Action Objectives*

The Record of Decision ("ROD") for the second operable unit ("OU2") for the Olean Well Field site considered risks on both a human health and ecological basis. The human health assessment addressed potential risk by identifying several potential exposure pathways by which the public may be exposed to at the site under current and future land-use conditions. The baseline risk assessment evaluated the health effects that would result from exposure to groundwater containing constituents of concern through three pathways; namely, ingestion, dermal contact and inhalation of volatilized constituents during showering. Risk as a result of constituents in surface and subsurface soils were calculated for an exposure scenario of ingestion or inhalation by construction workers. A residential exposure scenario was not calculated because the property is zoned and operated as industrial/commercial, and was expected to continue as such in the future.

The baseline risk assessment results indicated that ingestion of and dermal contact with untreated groundwater at the site poses the only unacceptable risks to human health. Risks due to the inhalation of constituents from untreated groundwater during showering were within EPA's acceptable risk range. Wellhead treatment at City Wells 18M and 37/38M provides protection from exposure from COCs in the groundwater. Risks calculated for ingestion and inhalation of surface and subsurface soils by construction workers were found to be acceptable at the Alcas site.

The ecological risk assessment concluded that there are no significant habitats present at the Alcas site which could potentially support indigenous wildlife receptor species.

With the use of institutional and engineered controls, groundwater at the Alcas site does not poses a risk to human health. The two main Remedial Action Objectives ("RAOs") identified for this site are:

- Minimize the migration of COCs from the site to the City Aquifer either by treating the source area in the upper aquitard or by intercepting the flow from the source area to 18M.
- Address the dissolved phase plume that has migrated to the south of the site.

Based on the current understanding of site conditions and RAO's, several remedial technology options can be considered. However, in addition to the typical FS evaluation criteria, two key stipulations and constraints must be adhered to throughout the evaluation process. These constraints are:

- The use of technologies that could alter groundwater chemistry or impact wellhead treatment at 18M and/or 37/38M will be eliminated from consideration;
- Minimize impact/disturbance to the ongoing manufacturing operations at the Cutco facility.

Four target areas have been identified at the site. Three of the target areas have been identified to minimize the migration of COCs from the site to the City Aquifer. They include shallow impacted soils, impacted groundwater flow from the source area in the Upper Aquitard, and the source areas in the Upper Aquitard. The fourth target area is included to address the dissolved phase plume in the Upper Aquitard south of the site.

Objective: Minimize the migration of COCs from the site to the City Aquifer

- Shallow Impacted Soils;
- Interception of Impacted Flow;
- Sources in the Upper Aquitard under the Main Building

Objective: Dissolved Phase Plume in the Upper Aqutard south of the site.

## 2.2 *Applicable or Relevant and Appropriate Requirements (ARARs)*

Chemical and remedy specific ARARs were evaluated as part of this FSS for the Alcas Site. The major ARARs considered include:

- State and Federal Maximum Contaminant Levels (MCLs) for drinking water;
- State and Federal Air Emission limits;
- National Pollution Discharge Elimination System (NPDES);
- State Pollution Discharge Elimination System (SPDES);
- RCRA Hazardous Waste generator, transporter, treatment and disposal requirements; and
- State Soil Clean-up Levels (TAGM 4046).

# 3.0 Screening Criteria

Screening of remedial technologies and technology process options is conducted in two stages. The first stage will evaluate technologies based on technical implementability and compliance with site-specific constraints. The second stage will evaluate technologies based on effectiveness, implementability, and cost.

## 3.1 *Primary Screening Criteria*

The initial screening consists of evaluating the technologies for technical implementability, whether the technology meets either remedial action objection, and can operate within the constraints detailed in Section 2.1.

During this screening step, process options and entire technology types are eliminated from further consideration on the basis of technical implementability. This is accomplished by using information from the site characterization to screen out technologies and process options that cannot be effectively implemented at the site. Two factors that commonly influence technology screening are the presence of inorganic contaminants and the subsurface conditions. The location of source material beneath the Main Building will limit some of the technologies from reaching the bulk of the source material, resulting in those technologies as being non-technically implementable.

Other technologies will be screened from further evaluation based on their effect on the local groundwater chemistry and/or disturbance to the ongoing manufacturing operations at the Cutco facility.

If technologies have not been screened from further evaluation based on technical implementability or the site-specific constraints, then the technologies will be evaluated further based on effectiveness, implementability, and cost.

## 3.2 *Secondary Screening Criteria*

Three criteria shall be used to evaluate technology types. Those criteria are:

- Effectiveness;
- Implementability; and
- Cost.

### *3.2.1* Effectiveness

Pursuant to 40 CFR §300.430(e)(7)(i), effectiveness focuses on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with applicable or relevant and appropriate requirements

(ARARs), minimizes short-term impacts, and how quickly it achieves protection to human health.

At this stage, the effectiveness of the remedial technologies will be evaluated based on:

- The potential effectiveness of process options in handling the estimated areas or volumes of media and meeting the remediation goals identified in the remedial action objectives,
- How proven and reliable the process is with respect to the contaminants and conditions at the site,
- Advantages and limitations,
- Compliance with ARARs,
- Long and Short Term Effectiveness, and
- Reduction of Toxicity, Mobility, or Volume through Treatment or Control.

### *3.2.2* Implementability

Pursuant to 40 CFR §300.430(e)(7)(ii), implementability focuses on the technical feasibility and availability of the technologies each alternative would employ and the administrative feasibility of implementing the alternative.

At this stage, the implementability of the remedial technologies is evaluated based on the institutional aspects of implementability. Those aspects include the ability to obtain necessary permits for offsite actions, the availability of treatment, storage, and disposal services, and the availability of necessary equipment and skilled workers to implement the technology.

### *3.2.3* Cost

Pursuant to 40 CFR §300.430(e)(7)(ii), costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated. The purpose of the remedy selection process is to implement remedies that eliminate, reduce, or control risks to human health and the environment.

At this stage, relative capital and O&M costs are used rather than detailed estimates. The cost analysis is made on the basis of engineering judgment, and each process is evaluated as to whether costs are high, low, or medium relative to other options.

# 4.0 Screening Evaluation

Four target areas have been identified at the site. Three of the target areas have been identified to minimize the migration of COCs from the site to the City Aquifer. They include shallow impacted soils, impacted groundwater flow from the source area in the Upper Aquitard, and the source areas in the Upper Aquitard. The fourth target area is included to address the dissolved phase plume in the Upper Aquitard south of the site.

Remedial technologies were developed to for each target area. Those technologies are described and evaluated below.

**RAO: Minimize Migration of COCs from the Site to the City Aquifer**

## 4.1 *Remedial Action Technologies for Shallow Impacted Soils*

The general response actions for the treatment of shallow impacted soils are listed below and described in the following sections:

- No Action,
- Excavation,
- Soil Vapor Extraction, and
- Capping.

### *4.1.1* No Action

This no action alternative, which is required pursuit to 40 CFR §300.430(e)(6), provides a baseline against which other technologies may be compared. Under the no action alternative, no additional cleanup would be undertaken, and the contaminated surface and subsurface soils in the identified source areas would be left as they now exist.

No remedial action is associated with this action; therefore, there is no impact to wellhead treatment at 18M and/or 37/38M or disruption to operations at the Cutco Facility. Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. This action offers no reduction of toxicity, mobility, or volume through treatment. There are no capital or O&M costs involved with this action.

Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented.

### *4.1.2* Excavation

Excavation will occur outside the Main Building and beyond major access roads at the site. Shallow excavation depths of 8 feet will have minimal impacts to the current manufacturing operations. After excavation of soils that exceed clean-up goals, the soil would be transported off-site and properly disposed. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Excavate impacted vadose zone soils with COC concentrations exceeding risk-based numbers for appropriate off-site disposal. Although most soil concentrations are below industrial cleanup standards, the more stringent levels established for protection of groundwater will apply (TAGM 4046).
- Backfill excavated area with clean imported fill.

Excavation of shallow impacted soils would effectively remove contaminant mass from the excavated areas. However, excavation on impacted soils beneath the main building cannot be accomplished without significant impact and disturbance to the ongoing manufacturing operations at the Cutco facility. Migration of COCs to the City Aquifer cannot be minimized without the removal of impacted soils beneath the Main Building.

Removing impacted soils outside of the Main Building will help to minimize any continuing impact from shallow soils (nonDNAPL source areas) to the dissolved phase plume in the Upper Aquitard south of the site. Therefore, excavation of shallow soils is NOT screened from further evaluation to minimize migration to the dissolved phase plume.

### *4.1.3* Soil Vapor Extraction

The SVE system would consists of vapor extraction wells, a vacuum blower or a pump, air/water separator, and a vapor treatment system. Removal of volatile compounds by SVE involves creating a vacuum at the extraction wells. Air in the surrounding soil containing the contaminated vapors then rushes to fill the vacuum, which is then extracted and treated before being released to the atmosphere. Granulated Activated Carbon (GAC) would be used to treat the extracted vapors. To treat target areas, the system would require installation of shallow vacuum points and trenching inside the Main Building. Generated air emissions must comply with State and Federal Air Emissions Limits.

Components of this technology include the following:

- Install a Soil Vapor Extraction (SVE) system to volatilize vadose zone impacts.
- A shallow sub-slab depressurization system (SSDS) would be installed to control vapors should indoor air intrusion becomes an issue.

As the air passes through the soil, it strips the soil of the volatile contaminants and therefore, an SVE system would effectively remove contaminant mass from the unsaturated zone above the water table and minimize migration of COCs to the City Aquifer.

However, due to the fine-grained nature of the vadose zone soils, the effective radius of extraction is limited. To reach the target areas beneath the Main Building, construction would need to occur inside the Main building, which would cause significant disruption to the ongoing manufacturing operations at the Cutco facility. Therefore, SVE is not an ideal remedial technology and is screened from further evaluation.

### *4.1.4* Capping

The unpaved area is prepared by proper grading of the existing soils to ensure that no standing water collects. A compacted layer of clay or bentonite admixture is then applied and a 6-inch thick layer of topsoil is placed on top of this compacted layer. Finally, the surface is vegetated to provide stabilization and to promote evapotranspiration. Any soil requiring disposal will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Clear area above impacted soils.
- Excavate top 3 to 5 feet of topsoil over impacted soils for installation of cap.
- Construct low permeability capping system over impacted vadose zone soils.
- Place layer of topsoil and vegetate surface for stabilization.

Proper capping and grading effectively reduces or eliminates off-site migration by preventing dust and diverting the flow of storm water. It also avoids percolation through the contaminated soil to the groundwater.

Capping impacted soils would not cause significant site disruption, impact Municipal wells or be difficult to implement. However, the bulk of the source material is located under the Main Building and capping the surrounding surface areas would not significantly minimize the migration of COCs to the City Aquifer.

The baseline risk assessment published in the ROD for the Olean Well Field determined that risk from ingestion and inhalation of surface and subsurface soil contaminants were found to be acceptable for each of the thirteen properties investigated, which includes the Alcas Site. Therefore, providing a barrier to exposure from ingestion and inhalation of soils will have minimal impact to the human health risks present at the site.

Based on capping's limited effectiveness in minimizing migration of COCs to the City Aquifer and reducing human health at the site, it has been screened from further evaluation.

**RAO: Minimize Migration of COCs from the Site to the City Aquifer**

## 4.2 *Remedial Action Technologies for the Interception of Impacted Groundwater*

The general response actions for intercepting impacted groundwater from the source area in the Upper Aquitard to minimize migration of COCs to the City Aquifer, are listed below and described in the following sections:

- No Action,
- Groundwater Extraction and Treatment,
- Permeable Reactive Barrier,
- Barrier Wall and Bottom Containment, and
- Groundwater Sparging.

### *4.2.1* No Action

This no action alternative would not minimize the migration of COCs to the City Aquifer. This technology is retained as a baseline against which other alternatives may be compared. Under this alternative, contaminants remain at the identified source areas, no additional remedial activities are performed, and site access is not further restricted.

No remedial action is associated with this action; therefore, there is no impact to wellhead treatment at 18M and/or 37/38M or disruption to operations at the Cutco Facility. Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. This action offers no reduction of toxicity, mobility, or volume through treatment. There are no capital or O&M costs involved with this action.

Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented.

### *4.2.2* Groundwater Extraction and Treatment

Groundwater extraction and treatment or ("pump and treat") is the most common form of groundwater remediation. Groundwater is removed from the subsurface by pumping, and treated before it is discharged. The well design, extraction system, and treatment are dependent on the site characteristics and contaminant type. Each of the process options described in this section employ a different extraction method for removing groundwater from the subsurface.

#### *4.2.2.1* <u>**Groundwater Extraction and Treatment using Collection Trench**</u>

A collection trench is excavated along the southeast portion of the site. Extracted groundwater is then treated with an air stripper and discharged to a NPDES outfall. System installation would require 3-4 weeks of significant site disruption and over the long-term the treatment system would require regular operational maintenance and monitoring. The treatment system is expected to operate for 30 years.

Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements. Air emissions will comply with State and Federal air emissions standards. Treated groundwater requiring discharge will do so in accordance with National and State pollution discharge elimination systems.

Components of this technology include the following:

- Conduct Geotechnical Study of feasibility of this technology.
- Identify and Isolate subsurface utilities that are present at the proposed trench location.
- Install a groundwater collection trench made up of biodegradable biopolymer slurry in the transition zone along the southeast portion of the site to intercept COCs from the upper source area.
- An air stripper will treat extracted groundwater and discharge to a NPDES outfall.
- Excavated materials from the top 35 feet will be used to re-fill the trench without any need of treatment or off-site disposal, and the excavated materials below the top 35 feet will be disposed as non-hazardous waste (subtitle D facility) as indicated by the existing sampling data.
- Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase.

Extraction of impacted groundwater for treatment would reduce the dissolved-phase VOCs mass, and establish hydraulic control to minimize plume migration toward the underlying City Aquifer and subsequently City Well 18M.

Groundwater collection using a collection trench would be technically implementable at the site. While some site disruption would occur during the installation of this treatment option it is not believed to be a major deterrent for implementing this technology. The use of biodegradable biopolymer slurry may impact the city well water quality and would need to be further evaluated prior to the final selection of this remedy.

The fine-grain nature of the transition zone soils may significantly reduce the effectiveness of this technology to control the hydraulic gradients in the area. Therefore, without a more detailed analysis of the soil's hydraulic conductivity, the long and short term effectiveness of this remedy option cannot be accurately evaluated at this time.

No institutional implementability obstacles are foreseen at this time. The cost of the technology is estimated to be medium compared to other options. The long-term structures of the treatment system would require regular O&M, as well as, an additional cost to dispose of trenched soils compared to other groundwater extraction methods.

At this stage, groundwater extraction and treatment using a collection trench is not screened from further evaluation.

#### *4.2.2.2* **Groundwater Extraction and Treatment using Vertical Extraction Wells**

Vertical extraction wells will be installed if hydraulic control cannot be achieved by utilizing on-site monitoring wells. Wells will extract groundwater from the transition zone along the southeast portion of the site. Extracted groundwater is then treated with an air stripper and discharged to a NPDES outfall. System installation would require 3-4 weeks of significant site disruption and over the long-term the treatment system would require regular operational maintenance and monitoring.

Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements. Air emissions will comply with State and Federal air emissions standards. Treated groundwater requiring discharge will do so in accordance with National and State pollution discharge elimination systems.

Components of this technology include the following:

- Install a groundwater extraction and treatment system in the transition zone along the southeast portion of the site to intercept COCs from the upper source area
- An air stripper will treat extracted groundwater and discharge to a NPDES outfall.
- Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase.

Extraction of impacted groundwater for treatment would reduce the dissolved-phase VOCs mass, and establish hydraulic control to minimize plume migration toward City Well 18M. Much less soil excavation and disposal will be required compared to the trenching method.

Groundwater collection using vertical extraction wells would be technically implementable at the site. While some site disruption would occur during the installation of this treatment option it is not believed to be a major deterrent for implementing this technology.

The fine-grain nature of the transition zone soils may significantly reduce the effectiveness to extract groundwater and control the hydraulic gradients in the area. Therefore, without a more detailed analysis of the soil's hydraulic conductivity, the long and short term effectiveness of this remedial option cannot be accurately evaluated at this time.

No institutional implementability obstacles are foreseen at this time. The cost of the technology is estimated to be medium compared to other options. The long-term structures of the treatment system would require regular O&M, but much less soil material would need disposing compared to the trenching method.

At this stage, groundwater extraction and treatment using vertical extraction wells is not screened from further evaluation.

#### *4.2.2.3* Groundwater Extraction and Treatment using Horizontal Extraction Wells

Horizontal extraction wells will be installed beneath the main building. Extracted groundwater is then treated with an air stripper and discharged to a NPDES outfall. System installation would require 3-4 weeks of significant site disruption and over the long-term the treatment system would require regular operational maintenance and monitoring.

Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements. Air emissions will comply with State and Federal air emissions standards. Treated groundwater requiring discharge will do so in accordance with National and State pollution discharge elimination systems.

Components of this technology include the following:

- Conduct Geotechnical Study of feasibility of this technology.
- Install a groundwater extraction and treatment system in the transition zone below the Main Building to intercept COCs from reaching the City Aquifer.
- An air stripper will treat extracted groundwater and discharge to a NPDES outfall.
- Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase.

Extraction of impacted groundwater for treatment would minimize the migration of COCs from the source area underneath the main building to the City Aquifer and over the long-term reduce the COC dissolved-phase concentration impacting City Well 18M.

The recovery of groundwater using horizontal extraction wells is technical implementable but the geotechnical feasibility of drilling beneath the Main Building would need to be further studied before this option is chosen. Buried utility lines beneath the building would also need to be located and identified before implementation of this technology. Site disruption would occur during the installation of this treatment option and is believed to be a major deterrent for implementing this technology.

Since groundwater transmissivity is generally greater in the horizontal direction, configuring the extraction wells horizontally would yield greater recovery of groundwater compared to vertical extraction wells. However, the fine-grain nature of the transition zone soils still may reduce the effectiveness to extract groundwater and control the hydraulic gradients in the area. Therefore, without a more detailed analysis of the soil's hydraulic conductivity, the long and short term effectiveness of this remedy option cannot be accurately evaluated at this time.

No institutional implementability obstacles are foreseen at this time. The cost of the technology is estimated to be high compared to other options. The long-term structures of the treatment system would require regular O&M, but much less soil material would need disposing compared to the trenching method.

At this stage, groundwater extraction and treatment using horizontal extraction wells is not screened from further evaluation.

### *4.2.3* Permeable Reactive Barriers

Permeable reactive barriers are permeable semi-permanent or replaceable units that are installed across the flow path of a contaminant plume. Physical, chemical, and/or biological processes remove contaminants present in the groundwater as it passes through the barrier. Each process reaction depends on a number of parameters such as pH, oxidation/reduction potential, chemical concentration, and kinetics.

The following section evaluates a Zero-Valent Iron (ZVI) PRB, placed in-situ using either the trenching method or by the fracing method.

#### *4.2.3.1* **Permeable Reactive Barrier using Trenching Method**

A permeable reactive barrier employing ZVI will be installed in the southeast portion of the site. The trench will be installed using the trenching method with use of biopolymer slurry. The PRB would be extend into the transition zone of the city aquifer approximately 35 ft to 50 ft below ground surface (bgs) and be approximately 250 feet in length, with effective ZVI thickness of 1 foot or more. The exact thickness of the treatment zone is dependent on both the COC concentration and groundwater flow velocities and therefore, a better understanding of concentration and flow velocities would need to be developed prior to implementation. System installation would require 3-4 weeks of significant site disruption. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Conduct Geotechnical Study of feasibility of this technology.
- Identify and Isolate subsurface utilities that are present at the proposed trench location.
- Install a permeable reactive barrier (PRB) using zero-valent iron (ZVI) perpendicular to groundwater flow along the eastern portion of the site,
- Install performance-monitoring wells which would require periodic (annual) sampling and upkeep.
- Excavated materials from the top 35 feet can be used to re-fill trench without any need of treatment or off-site disposal, and the excavated materials below the top 35 feet could be disposed as non-hazardous waste (subtitle D facility) as indicated by the existing sampling data.

Permeable reactive barriers utilizing ZVI have successfully treated chlorinated VOCs at a number of other sites, and the effectiveness of the ZVI has shown good longevity. Minimizing COCs from entering the City Aquifer by installing a ZVI PRB trench would be technically implementable.

The release of soluble iron into the groundwater would not likely impact wellhead treatment at 18M and/or 37/38M, as increased iron concentrations typically do not extend more than a few feet down gradient of the PRB except in low pH conditions. In those cases that the pH is high, soluble iron precipitates to form ferrous hydroxide or ferric hydroxide. Impact to wellhead treatment from iron precipitates is not expected, but the use of biodegradable biopolymer slurry may impact the city well water quality and would need to be further evaluated prior to the final selection of this remedy.

Using a ZVI permeable reactive barrier has shown reliability in treating chlorinated dissolved phase constituents and shown good longevity, but without operating in combination with a source removal technology, the operating life may need to be extended past 30 years. During that time the short-term effectiveness of this technology is estimated to be medium to high and the long-term effectiveness is estimated to be high when compared to other process options.

Implementation of this technology will be difficult. Construction of a barrier wall approximately 50 feet deep may be technically impractical. Without a fully penetrating barrier wall reduction to the volume of dissolved phase constituents may not be accomplished. The groundwater toxicity with respect to human health and exposure from groundwater ingestion from nearby Municipal Wells will likely be unaffected, since COC concentrations near the wells will remain unaltered from impacts from other off-site sources.

No institutional implementability obstacles are foreseen at this time. The periodic monitoring of performance-monitoring wells, initial disposal of trenched soil and comparably low O&M costs compared to other technologies has contributed to a relative low cost for this technology.

At this stage, a PRB using the trenching method is screened from further evaluation based on this technologies disruption to the ongoing site operations, and its inability to reduce impacts to human health at the wellhead.

#### *4.2.3.2* **Permeable Reactive Barrier using Fracing Method**

Approximately thirty-six frac boreholes will be installed in two rows in the southeast portion of the site. Within each borehole, an estimated 7 fractures will be created and filled with ZVI. The fracing process generates a minimal amount of aquifer material requiring disposal, but some residual water/guar used in the injection mixing tanks may require off-site disposal. The effective ZVI thickness is estimated to be only 3 inches for this alternative. A better understanding of concentration and flow velocities would need to be developed prior to implementation of this alternative to determine if 3 inches is sufficient. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install approximately of 36 frac boreholes (in two rows with borehole spacing of approximately 15 feet within each row) to a depth of 50 feet bgs.
- Conduct Geotechnical Study of feasibility of this technology.

- Within each borehole a total of 7 fractures will be created for ZVI emplacement, one fracture to be initiated every 2.5 feet from 50 feet bgs to 35 feet bgs.
- Install a six performance-monitoring wells, which will require periodic sampling and upkeep.

ZVI have successfully treated chlorinated VOCs at a number of other sites, and the effectiveness of the ZVI has shown good longevity. Minimizing COCs from entering the City Aquifer by installing ZVI filled frac boreholes would be technically implementable. However, installation of the trench would require 3-4 weeks of construction, causing significant disruption to the operations at the Cutco Facility.

The release of soluble iron into the groundwater would not impact wellhead treatment at 18M and/or 37/38M, as increased iron concentrations typically do not extend more than a few feet down gradient of the PRB except in low pH conditions. In those cases that the pH is high, soluble iron precipitates to form ferrous hydroxide or ferric hydroxide. Impact to wellhead treatment from iron precipitates is not expected, but the use of biodegradable biopolymer slurry may impact the city well water quality and would need to be further evaluated prior to the final selection of this remedy.

Using a ZVI permeable reactive barrier has shown reliability in treating chlorinated dissolved phase constituents and shown good longevity, but without operating in combination with a source removal technology, the operating life may need to be extended past 30 years. During that time the short-term effectiveness of this technology is estimated to be medium and the long-term effectiveness is estimated to be medium to high when compared to other process options.

Reduction to the volume of dissolved phase constituents will be accomplished with this technology. However, the groundwater toxicity with respect to human health and exposure from groundwater ingestion from nearby Municipal Wells will be unaffected, since COC concentrations near the wells will remain unaltered from impacts from other off-site sources.

No institutional implementability obstacles are foreseen at this time. The periodic monitoring of performance-monitoring wells, initial disposal of excavated borehole soil, and comparably low O&M costs compared to other technologies has contributed to a relative low cost for this technology.

At this stage, a PRB using the fracing method is not screened from further evaluation.

### *4.2.4* Barrier Wall and Bottom Containment with Bentonite Slurry

Horizontal extraction wells will be installed beneath the main building and filled with bentonite slurry. Horizontal wells would be installed with zero to minimal spacing between wells. A L-shaped containment trench is installed downgradient of horizontal groundwater flow and filled with bentonite slurry. The trench is positioned around the source area beneath the Main Building. System installation would require 3-4 weeks of significant site disruption. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Identify and Isolate subsurface utilities that are present at the proposed trench location.
- Conduct Geotechnical Study of feasibility of this technology.
- A L-shaped containment trench is installed down to the Upper Aquitard, positioned downgradient of groundwater flow around the Main Building.
- Horizontal wells will be installed beneath the Main Building to prevent vertical groundwater flow.
- The trench and horizontal wells will be filled with bentonite slurry to contain the source area beneath the building.
- Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase.

Together the trench and horizontal wells create a perimeter around the source area beneath the Main Building, preventing the migration of dissolved phase COCs to the upper water bearing zone and the underlying City Aquifer.

The technical implementability of this option relies solely on the installation of horizontal wells beneath the Main Building with minimal spacing between boreholes to effectively construct bottom containment. The installation of the trench and horizontal wells would require at a minimum, 6-8 weeks of construction, causing significant disruption to the operations at the Cutco Facility. Impact to municipal wellhead treatment at 18M or 37/38M is not expected.

Little guarantee can be given to the accuracy of constructing horizontal wells with minimal spacing. Due to large number and likely inaccuracies associated with installation of numerous horizontal wells, the short-term and long-term effectiveness of this technology is low. Therefore, this technology is screened from further evaluation.

### *4.2.5* Groundwater Sparging

Horizontal extraction wells will be installed beneath the main building. Air will be released beneath the source area to allow for volatilization of contaminants. If necessary, a shallow sub-slab depressurization system will be deployed to remove vapors at the surface. System installation would require 3-4 weeks of significant site disruption and over the long-term the injection system would require regular operational maintenance and monitoring. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements. Air emissions will comply with State and Federal air emissions standards.

Components of this technology include the following:

- Conduct Geotechnical Study of feasibility of this technology.
- Install Horizontal Wells beneath the Site as conduit to deliver air to the source zone beneath the building.
- Deploy a shallow sub-slab depressurization system (SSDS) to control vapors should indoor air intrusion become an issue.
- Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase.

The sparging of groundwater using horizontal wells is technical implementable but the geotechnical feasibility of drilling beneath the Main Building would need to be further studied before this option is chosen. Buried utility lines beneath the building would also need to be located and identified before implementation of this technology. While some site disruption would occur during the installation of this treatment option it is not believed to be a major deterrent for implementing this technology. Increasing the dissolved oxygen (DO) consent of the groundwater is not expected to impacted wellhead treatment at Municipal Wells 18M and 37/38M.

Long horizontal screens contact a large impacted area and can effectively transmit additives to impacted areas. Volatilization of COCs will reduce dissolved-phase VOC mass and the potential exists for additives to enhance biodegradation of constituents. However, enhanced biodegradation through the addition of DO may lead unwanted byproducts, such as vinyl chloride.

No institutional implementability obstacles are foreseen at this time for this treatment technology. The long-term structures of the treatment system would require regular O&M, as well as, the cost to dispose of excavated soils has contributed to a medium cost for this technology.

Based on the initial phases of the Remedial Investigation conducted in 1984, it was theorized that air sparging and soil vapor extraction may be a viable option. However, after an additional soil investigation was performed, it was determined that the hydrogeologic conditions at the site are not favorable to air sparging and soil vapor extraction (SVE). All of which was documented in a letter to the EPA dated September 7, 1994. Specifically, the letter concluded the following:

> "The non-homogeneous subsurface geology within the proposed pilot test location at the Alcas facility discounts the applicability of air sparging coupled with SVE as a remedial strategy. The layered geology of highly permeable and impermeable layers would result in a situation of uncontrolled sparging. Uncontrolled sparging occurs when air is injected into a permeable layer, then rises to an impermeable layer. The air bubbles cannot penetrate the impermeable layer and move in a horizontal rather then vertical direction. The bubbles will continue to move in the horizontal direction until they reach another permeable layer where they will rise vertically. Uncontrolled sparging has the potential to

> spread contaminants throughout the subsurface, which is why a fairly homogeneous geology is needed for application of the air sparging technology."

Base on the geological conditions at the site, the previous assessment is still valid, and groundwater sparging is screened from further evaluation.

**RAO: Minimize Migration of COCs from the Site to the City Aquifer**

## 4.3 *Remedial Action Technologies for Treating Sources in the Upper Aquitard Beneath the Main Building*

The general response actions for the treatment of sources in the Upper Aquitard are listed below and described in the following sections:

- No Action,
- Permeable Reactive Barriers,
- In-situ Chemical Oxidation/Biodegradation,
- Groundwater/Dual Phase Extraction, and
- Electric Resistance Heating.

### *4.3.1* No Action

This no action alternative would not treat the sources in the Upper Aquitard. This technology is retained as a baseline against which other alternatives may be compared. Under this alternative, contaminants remain at the identified source areas, no additional remedial activities are performed, and site access is not further restricted.

No remedial action is associated with this action; therefore, there is no impact to wellhead treatment at 18M and/or 37/38M or disruption to operations at the Cutco Facility. Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. This action offers no reduction of toxicity, mobility, or volume through treatment. There are no capital or O&M costs involved with this action.

Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented.

### *4.3.2* Permeable Reactive Barriers

Permeable reactive barriers are permeable semi-permanent or replaceable units that are installed across the flow path of a contaminant plume. Physical, chemical, and/or biological processes remove contaminants present in the groundwater as it passes through the barrier. Each process reaction depends on a number of parameters such as pH, oxidation/reduction potential, chemical concentration, and kinetics.

#### *4.3.2.1* Multiple ZVI Treatment Zones using Fracing Method

Approximately thirty-seven frac boreholes will be installed in multiple rows in the source area of the site under the Main Building. Within each borehole, 8 fractures will be created and filled with ZVI. The fracing process generates a minimal amount of aquifer material requiring disposal, but some residual water/guar used in the injection mixing tanks may require off-site disposal. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Conduct Geotechnical Study of feasibility of this technology.
- Install approximately 37 frac boreholes (in multiple rows with borehole spacing of approximately 20 feet within each row) to a depth of 28 feet bgs.
- Within each borehole a total of 8 fractures will be created for ZVI emplacement, one fracture to be initiated every 2.5 feet from 25.5 feet bgs to 8 feet bgs.
- No new monitoring wells required for performance monitoring.

Although this is a relatively new technique for increasing distribution in low hydraulic conductivity soils, the frac borehole locations will cover the residual source areas beneath the building. The ZVI performance is well documented, but primarily requires the COCs to come in contact with the iron. Although the ZVI filled fractures will only be located in a portion of the aquifer volume, their higher hydraulic conductivity should cause groundwater to preferentially flow through them. Placement of multiple horizontal iron zones would treat the water as it moves through the aquitard and into the transition zone.

ZVI have successfully treated chlorinated VOCs at a number of other sites, and the effectiveness of the ZVI has shown good longevity.

Treating the sources in the Upper Aquitard by installing ZVI filled frac boreholes would be technically difficult but may be implementable. Additionally, accessibility of drilling equipment in the building is a limiting factor.

The release of soluble iron into the groundwater would not impact wellhead treatment at 18M and/or 37/38M, as increased iron concentrations typically do not extend more than a few feet down gradient of the PRB except in low pH conditions. In those cases that the pH high, soluble iron precipitates to form ferrous hydroxide or ferric hydroxide. Impact to wellhead treatment from iron precipitates is not expected, but the use of biodegradable biopolymer slurry may impact the city well water quality and would need to be further evaluated prior to the final selection of this remedy.

The short-term effectiveness of this technology is estimated to be medium to high and the long-term effectiveness is estimated to be medium, depending on the longevity of the reactive media, when compared to other process options. The ZVI estimated effectiveness is 10 years, and during that time COC concentrations are estimated to be reduced to monitored natural attenuation levels in the fraced source areas.

Reduction to the migration, toxicity, and volume of source material will be accomplished with this technology. No institutional implementability obstacles are foreseen at this time. The periodic monitoring of performance-monitoring wells, initial disposal of excavated borehole soil, and comparably low O&M costs compared to other technologies has contributed to a relative low cost for this technology.

Although significant site disruption will occur, a ZVI PRB using the fracing method is found to be the best remedial technology to remove source material and therefore, is not screened from further evaluation.

### *4.3.3* In-situ Chemical Oxidation/Biodegradation

The objective of chemical oxidation is to detoxify hazardous wastes by adding an oxidizing agent to chemically transform the waste. Oxidation and reduction reactions occur in pairs to make up an overall redox reaction. In the oxidation of hazardous wastes, an oxidizing agent is added to oxidize the COC, which serves as the reducing agent. Oxidizing agents are nonspecific and will react with any reducing agents or organics present in the groundwater. The process is most economical when organics other than the COCs are in low concentration.

Biological treatment systems typically rely on the interactions of different types of living organisms, including bacteria, fungi, algae, and protozoa. Treatment processes must promote and maintain a microbial population that metabolizes the target waste. A number of factors influence the effectiveness of biological treatment, including the type and concentration of carbon sources, electron acceptors, moisture, temperature, pH, and inorganic nutrients.

#### *4.3.3.1* **In-situ Chemical Oxidation using Persulfate/Permanganate**

Boreholes will be installed inside of the Main Building and filled with sand. Construction of injection wells will follow the installation of the boreholes and allow for injection of Persulfate or Permanganate. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install boreholes with placement of sand followed by injection well installation due to the low soil permeability.
- Treatment consists of multiple injection events with Persulfate/Permanganate.
- No new monitoring wells required for performance monitoring.

Persulfate and permangante have demonstrated successful dechlorination of site-specific COCs at many other locations.

The exact location of the suspected numerous source areas and the limited distribution of the oxidant through the geological formation greatly limits the short-term and long-term effectiveness of this technology. The residual sources underneath the building will not be treated, and "rebounding" of the treated areas would occur and continue to impact the City Aquifer. Changes in the water chemistry as a result of chemical oxidation may impact wellhead treatment at 18M or 37/38M, requiring additional treatment at the wellhead. Therefore, in-situ chemical oxidation using persulfate or permanganate is screened from further evaluation.

#### *4.3.3.2* **In-situ Chemical Oxidation using Ozone**

Boreholes will be installed outside of the Main Building and filled with sand. Construction of injection wells will follow the installation of the boreholes and allow for injection of ozone. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install boreholes with placement of sand followed by injection well installation due to the low soil permeability.
- Multiple injection events with ozone
- No new monitoring wells required for performance monitoring.

Ozone is a powerful oxidant, stronger than persulfate or permanganate, and readily reacts with toxic organics, including chlorinated ethenes. The reaction between ozone and organic compounds consists of the breaking of double bonds producing aldehydes and ketones.

Injecting ozone is expected to reduce VOC mass near the injection points, but residual sources underneath the building would go untreated. The rapid reaction rate with ozone limits ozone transport over large distances. This results in a limited radius of influence around the injection point. The exact location of the suspected numerous source areas and the limited distribution of the oxidant through the geological formation greatly limits the short-term and long-term effectiveness of this technology. Once decayed, ozone leaves no taste or odor in water and thus, not expected to impact wellhead treatment at 18M or 38/38M.

The limited influence, coupled with the untreated residual source area underneath the Main Building, which could re-contaminate the treated zone and continue to impact to the city aquifer, screens in-situ chemical oxidation using ozone from further evaluation.

#### *4.3.3.3* **Enhanced Anaerobic Biodegradation**

Boreholes will be installed outside of the Main Building and filled with sand. Construction of injection wells will follow the installation of the boreholes and allow for injection of EOS. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install boreholes with placement of sand first followed by injection well installation due to the low soil permeability.
- Multiple injection events with an electron donor such as Edible Oil Sustrate (EOS), bioaugmentation may be required in some cases.

- No new monitoring wells required for performance monitoring.

EOS has demonstrated successful dechlorination of site-specific COCs at many other locations. The Liquid electron donor is easier to distribute than ZVI.

Injecting EOS is expected to reduce VOC mass near the injection points, but residual sources underneath the building will go untreated. The use of organic carbon-rich electron donor, which will increase the biological and chemical oxygen demand (BOD/COD) in the groundwater, could potentially impact operation of city water treatment at 18M or 37/38M.

The impact to wellhead treatment of municipal wells, coupled with the untreated residual source area underneath the Main Building, which could rebound the treated zone and continue to impact to the city aquifer, screens in-situ enhanced anaerobic biodegradation from further evaluation.

### *4.3.4* Groundwater/Dual Phase Extraction

Install a dual-phase groundwater extraction and treatment system within the source area beneath the Main Building. Extracted groundwater is then treated with an air stripper and the treated groundwater is discharged to a NPDES outfall.

Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements. Air emissions will comply with State and Federal air emissions standards. Treated groundwater requiring discharge will do so in accordance with National and State pollution discharge elimination systems.

Components of this technology include the following:

- Install a dual-phase groundwater extraction and treatment system within the source area of the Upper Aquitard.
- Treat the extracted groundwater with an air stripper and discharge to a NPDES outfall.

Dual-phase extraction, also known as multi-phase extraction, vacuum-enhanced extraction, or sometimes bioslurping, is an *in-situ* technology that uses pumps to remove various combinations of contaminated groundwater, separate-phase product, and contaminante vapor from the subsurface.

Dual-phase extraction systems can be effective in removing separate-phase product (free product) from the subsurface, thereby reducing concentrations of in both the saturated and unsaturated zones of the subsurface. The technology also stimulates biodegradation of constituents in the unsaturated zone by increasing the supply of oxygen, in a manner similar to that of bioventing.

Extraction of impacted groundwater for treatment would reduce the residual contaminant mass in the Upper Aquitard, and hence reduce the impact to the underlying City Aquifer.

The technical implementability of this treatment option has no foreseen complications and is not expected to impact wellhead treatment at 18M and/or 37/38M or the operations at the Cutco Facility.

Although the actual performance of groundwater dual phase extraction cannot be accurately determined for the site, performance of such systems in this type of lithology is often marginal. Thus its long and short term effectiveness is estimated to be low.

Therefore, at this stage, groundwater dual phase extraction is screened from further evaluation based on its limited effectiveness in the removal of site contaminants.

#### *4.3.5* Electric Resistance Heating

Electrodes are installed in the subsurface throughout the source area to heat the soil. Contaminant volatilization is then collected for treatment. Implementation is very site disruptive and would require closing off the treatment zone for a significant period. Air emissions will comply with State and Federal air emissions standards.

Components of this technology include the following:

- Place electrodes in the subsurface throughout the target remediation area, and resistance to the flow of electrical current between electrodes would result in heating of the targeted soil.
- Vapors containing contaminants would be collected for treatment.

Treatment is very effective in removing VOCs mass even in low permeability heterogeneous lithologies. Increased volatilization and in-situ steam stripping would remove contaminants from the subsurface in treated areas, but residual sources underneath the building will go untreated.

Implementing this technology is very site disruptive. It would require closing off the treatment zone for up to a year and pose several significant safety issues for on-going plant operations. For that reason, electric resistance heating is screened from further evaluation.

**RAO: Address Dissolved Phase Plume in the Upper Aquitard south of the site**

### 4.4 *Remedial Action Technologies for the Dissolved Phase Plume in Upper Aquitard south of the site*

The dissolved phase plume south of the site is located on private property. Any remedial technology selected for this area may require the permission of the landowner prior to implementing. The general response action for treatment of dissolved phase contamination in the Upper Aquitard south of the site are listed below and described in the following sections:

- No Action,
- In-situ Chemical Oxidation/Biodegradation,
- Groundwater/Dual Phase Extraction, and
- Monitored Natural Attenuation.

### *4.4.1* No Action

This no action alternative would not treat the dissolved phase plume in the Upper Aquitard south of the site. This alternative is retained as a baseline against which other technologies may be compared. Under this alternative, contaminants remain at the identified source areas, no additional remedial activities are performed, and site access is not further restricted.

No remedial action is associated with this action; therefore, there is no impact to wellhead treatment at 18M and/or 37/38M or disruption to operations at the Cutco Facility. Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. This action offers no reduction of toxicity, mobility, or volume through treatment. There are no capital or O&M costs involved with this action.

Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented.

### *4.4.2* In-situ Chemical Oxidation/Biodegradation

The objective of chemical oxidation is to detoxify hazardous wastes by adding an oxidizing agent to chemically transform the waste. Oxidation and reduction reactions occur in pairs to make up an overall redox reaction. In the oxidation of hazardous wastes, an oxidizing agent is added to oxidize the COC, which serves as the reducing agent. Oxidizing agents are nonspecific and will react with any reducing agents or organics present in the groundwater. The process is most economical when organics other than the COCs are in low concentration.

Biological treatment systems typically rely on the interactions of different types of living organisms, including bacteria, fungi, algae, and protozoa. Treatment processes must promote and maintain a microbial population that metabolizes the target waste. A number of factors influence the effectiveness of biological treatment, including the type and concentration of carbon sources, electron acceptors, moisture, temperature, pH, and inorganic nutrients.

#### *4.4.2.1* **In-situ Chemical Oxidation using Potassium Permanganate**

One hundred and seventy injection points are installed to the south of the Main Building to a depth of 20 ft bgs. Once a year for the first three years, potassium Permanganate is injected into the Upper Aquitard. Three new monitoring wells will be installed to monitor the permanganate treatability. Semi-annual performance monitoring would be conducted during the first year and annual performance monitoring would be conducted during the following two years. Site disruption will occur during the first three years when implementing the injections. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install 170 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.
- Inject 500 gallons of 2% potassium permanganate per injection point.
- Assume three rounds of injection (one every year), and full-scale implementation for the first two injection events while 50% for the third injection event.
- Install 3 new monitoring wells for performance monitoring.

Permanganate has demonstrated successful dechlorination of site-specific COCs at many other locations. It is anticipated that this alternative will reduce the COC levels to Monitored Natural Attenuation levels within 3 years.

However, during those 3 years, the multi-week injection events will cause somesite disruption to the operations at the Cutco Facility, and changes to the water chemistry as a result of chemical oxidation may impact wellhead treatment at 18M or 37/38M, requiring additional treatment. Therefore, in-situ chemical oxidation, using potassium permanganate, on the dissolved phase plume in the Upper Aquitard south of the site is screened from further evaluation.

#### *4.4.2.2* **In-situ Chemical Oxidation using Persulfate**

One hundred and seventy injection points are installed to the south of the Main Building to a depth of 20 ft bgs. Three new monitoring wells will be installed to monitor the persulfate treatability. Performance monitoring would be conducted to monitor oxidation of COCs. Site disruption will occur during the first three years when implementing the injections. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install 170 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.
- Multiple injection events with Persulfate
- Install 3 new monitoring wells for performance monitoring.

Persulfate has demonstrated successful dechlorination of site-specific COCs at many other locations.

The multi-week injection events will cause some site disruption to the operations at the Cutco Facility, but persulfate is not expected to impact the water chemistry as significantly as the use of Permanganate. Therefore, in-situ chemical oxidation, using persulfate, on the dissolved phase plume in the Upper Aquitard south of the site is not screened from further evaluation.

#### *4.4.2.3* **In-situ Chemical Oxidation using Ozone**

One hundred and seventy injection points are installed to the south of the Main Building to a depth of 20 ft bgs. Three new monitoring wells will be installed to monitor the ozone treatability. Performance monitoring would be conducted to monitor oxidation of COCs. Site disruption will occur during the first three years when implementing the injections. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install 170 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.
- Multiple injection events with ozone
- Install 3 new monitoring wells for performance monitoring.

Ozone is a powerful oxidant, stronger than persulfate or permanganate, and readily reacts with toxic organics, including chlorinated ethenes. The reaction between ozone and organic compounds consists of the breaking of double bonds producing aldehydes and ketones.

Injecting ozone is expected to reduce VOC mass near the injection points. The rapid reaction rate with ozone limits ozone transport over large distances. This results in a limited radius of influence around the injection point. Once decayed, ozone leaves no taste or odor in water and thus, not expected to impact wellhead treatment at 18M or 38/38M.

In-situ chemical oxidation using ozone is not screened from further evaluation.

#### *4.4.2.4* **Enhanced Anaerobic Biodegradation**

Semi-annual performance monitoring would be conducted during the first year and annual performance monitoring would be conducted during the following five years. Site disruption will occur during the first six years when implementing the injections. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install approximately 170 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.
- Inject 500 gallons of 1% EOS amendment per injection point.
- Assume three rounds of injection (one every two years), and full-scale implementation for the first two injection events while 50% for the third injection event.
- Install 3 new monitoring wells for performance monitoring.

EOS has demonstrated successful dechlorination of site-specific COCs at many other locations. It is anticipated that this alternative will reduce the COC levels to Monitored Natural Attenuation (MNA) levels within 6 years.

However, during those 6 years, the multi-week injection events will cause a some site disruption to the operations at the Cutco Facility, and the use of organic carbon-rich electron donor, which will increase the biological and chemical oxygen demand (BOD/COD) in the groundwater, could potentially impact operation of city water treatment at 18M or 37/38M. Therefore, in-situ enhanced anaerobic biodegradation of the dissolved phase plume in the Upper Aquitard south of the site is screened from further evaluation.

### *4.4.3* Groundwater/Duel Phase Extraction

Install a dual-phase groundwater extraction and treatment system with in the Upper Aquitard. Extracted groundwater is then treated with an air stripper and the treated groundwater is discharged to a NPDES outfall. Extraction wells are connected with underground piping that runs back to the treatment system at the facility.

Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements. Air emissions will comply with State and Federal air emissions standards. Treated groundwater requiring discharge will do so in accordance with National and State pollution discharge elimination systems.

Components of this technology include the following:

- Install a dual-phase groundwater extraction and treatment system within the Upper Aquitard.
- Treat extracted groundwater with an air stripper and discharge to a NPDES outfall.

Dual-phase extraction, also known as multi-phase extraction, vacuum-enhanced extraction, or sometimes bioslurping, is an *in-situ* technology that uses pumps to remove various combinations of contaminated groundwater, separate-phase product, and contaminante vapor from the subsurface.

Dual-phase extraction systems can be effective in removing separate-phase product (free product) from the subsurface, thereby reducing concentrations of in both the saturated and unsaturated zones of the subsurface. The technology also stimulates biodegradation of constituents in the unsaturated zone by increasing the supply of oxygen, in a manner similar to that of bioventing.

Extraction of impacted groundwater for treatment would reduce the residual contaminant mass in the Upper Aquitard, and hence reduce the time required to achieve MNA levels.

The technical implementability of this treatment option has no foreseen complications and is not expected to impact wellhead treatment at 18M or 37/38M.

The treatment system will require permanent extraction wells connected with underground piping that runs to the treatment system at the facility. Periodic O&M would require access to the off-site property and have minimal expected impact to operations at the Cutco Facility. However, due to the limited effects caused by the geological conditions of the area vapor extraction technology would have minimal effectiveness in this area. Therefore, groundwater duel phase extraction of the dissolved phase plume in the Upper Aquitard south of the site is screened from further evaluation.

### *4.4.4* Monitored Natural Attenuation

Install 3 new monitoring wells to monitor site conditions. Then conduct eight quarterly monitoring events in the first two years and annual for the next 28 years. Soils will be disposed of in accordance with RCRA Hazardous Waste generator, transporter, treatment and disposal requirements.

Components of this technology include the following:

- Install 3 new monitoring wells for performance monitoring.
- Perform 8 quarterly MNA monitoring events during the first two years.
- Perform annual MNA monitoring events after the first two years.
- Assumes 30 years for cleanup.

Groundwater monitoring has shown favorable results in the area of RU-8 in the form of natural biodegradation of TCE to cis-1,2-DCE and vinyl chloride.

The technical implementability of this treatment option has no foreseen complications and is not expected to impact wellhead treatment at 18M and/or 37/38M or the operations at the Cutco Facility.

Over the short-term the treatment effectiveness of this option is estimated to be low, and the long-term is estimated to be medium when compared to other treatment options. It is estimated that treatment may last over 30 years before MNA levels are reached.

There are no foreseen institutional implemenability complications, and the cost is estimated to be low, as there are no ongoing operation and maintenance costs required for this treatment option. Thus, MNA is not screened from further evaluation.

A summary of Screened Remedial Technologies is listed in Table 4-1 located in Appendix A.

## 5.0 Advancing Technology Summary

The following technologies are held for further evaluation to minimize the migration of COCs from the Site to the City Aquifer.

- No Action to shallow impacted soils, intercepted impacted groundwater, or the source area in the Upper Aquitard;
- Excavation of shallow impacted soils;
- Groundwater extraction and treatment of intercepted groundwater flow from the source area using a collection trench;
- Groundwater extraction and treatment of intercepted groundwater flow from the source area using vertical extraction wells;
- Groundwater extraction and treatment of intercepted groundwater flow from the source area using horizontal extraction wells;
- ZVI Permeable Reactive Barrier using Fracing Method to treat intercepted groundwater flow from the source area; and
- Multiple ZVI Treatment Zones using Fracing Method to treat the source areas beneath the Main Building.

The following technologies are held for further evaluation to address the dissolved phase plume in the Upper Aquitard south of the site.

- No Action to the dissolved phase plume;
- In-situ chemical oxidation using persulfate;
- In-situ chemical oxidation using ozone; and
- Monitored Natural Attenuation.

# Appendix A: Tables

**Table A-1.**
**ALCOA OLEAN SITE TECHNOLOGIES ANALYSIS**

**OLEAN, NEW YORK**

| RAO | Option | | Design Basis and Assumptions | Advantages | Disadvantages | Short-term Effectiveness | Long-term Effectiveness | Relative Costs | Retained from Screening (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|
| Minimize the migration of COCs from the Site to the City Aquifer | Shallow Impacted Soils | No Action | ● No remedial action is associated with this action.<br>● Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented. | ● No impact to wellhead treatment at 18M and/or 37/38M.<br>● No disruption to operations at the Cutco Facility.<br>● Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. | ● This action offers no reduction of toxicity, mobility, or volume through treatm | Low | Low | Low | Yes |
| | | Excavation | ● Excavate impacted vadose zone soils with COC concentrations exceeding risk based numbers for appropriate off-site disposal. Although most soil concentrations are below industrial cleanup standards, the more stringent levels established for protection of groundwater will probably apply.<br>● Backfill with clean imported fill. | ● No capital cost or ongoing operation and maintenance of treatment system.<br>● Very effective in removing mass from the excavated area, however given site limitations (i.e., active facility) the known vadose zone impacts in the vicinity of former boring B-3 inside the main building will not be addressed.<br>● Excavation will occur outside the main building and beyond major access roac at the site. Shallow excavation depths (8') should mitigate impacts to current owner. | ● Unable to address the known vadose zone impacts in the vicinity of former boring B-3 inside the main building, due to the given site limitations (i.e., active facility). | Low | Low | Low | Yes |
| | | Soil Vapor Extraction | ● Conduct Pilot Study<br>● Install a Soil Vapor Extraction (SVE) system to clean up vadose zone impacts and deploy as a shallow sub-slab depressurization system (SSDS) to control vapors should indoor air intrusion become an issue. | ● SVE technologies can remove VOCs in vadose zone soil and mitigate vapor intrusion, if any, under appropriate conditions. | ● Requires installation of shallow vacuum points and connecting trenching inside the building.<br>● Long-term structure (e.g., blower with GAC vapor treatment) and regular O&M would be required.<br>● Fine grain nature of the vadose zone soils may significantly reduce the effectiveness of this technology as a method of cleanup. | Low | Low | High | No, however SSDS should be re-evaluated if indoor air quality becomes an issue |
| | | Capping | ● Clear area above impacted soils.<br>● Excavate top 3 to 5 feet of topsoil over impacted soils for installation of cap.<br>● Construct low permeability cover system over impacted vadose zone soils, to control gas volatilization and surface water infiltration.<br>● Install vegetative support layer and vegetation over cover. | ● Minimizes leachate from impacted soils resulting from precipitation or stormwater runoff.<br>● Minimize soil vapor directly above impacted soils.<br>● Minimal ongoing operation or maintenance of treatment system. | ● System does not remove/treat VOCs in vadose zone. | Low | Low | Low | No, due to limited effectiveness |
| Minimize the migration of COCs from the Site to the City Aquifer (Cont.) | Interception of Impacted Flow | No Action | ● No remedial action is associated with this action.<br>● Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented. | ● No impact to wellhead treatment at 18M and/or 37/38M.<br>● No disruption to operations at the Cutco Facility.<br>● Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. | ● This action offers no reduction of toxicity, mobility, or volume through treatm | Low | Low | Low | Yes |
| | | Groundwater Extraction and Treatment using Collection Trench | ● Install a groundwater collection trench in the transition zone along the southeast portion of the site to intercept COCs from the upper source area, and provide hydraulic control as well as reduction of dissolved-phase COCs mass. It is assumed that extracted groundwater would be treated with an air stripper and discharged to a NPDES outfall.<br>● Some subsurface utilities are present at the proposed trench location, but are anticipated to be easily identified and isolated.<br>● Assume the excavated materials from the top 35 feet can be used to re-fill trench without any need of treatment or off-site disposal, and the excavated materials below the top 35 feet could be disposed as non-hazardous waste (subtitle D facility) as indicated by the existing sampling data.<br>● Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase. | ● Extraction of impacted groundwater for treatment would reduce the dissolved-phase VOCs mass, and also establish hydraulic control to minimize plume migration toward city well 18M. | ● System installation would requires 3-4 weeks of significant site disruption.<br>● Disposal cost of trench soil as a result of collection trench construction.<br>● Long-term structure and treatment system which would require regular OM&M.<br>● Fine grain nature of the transition zone soils may significantly reduce the effectiveness of this technology as a method of cleanup.<br>● Construction method of the collection trench would involve the use of a biodegradable biopolymer slurry - an evaluation of any potential impacts to the city well water quality would need to be further evaluated prior to final selection of this remedy. | Medium (effectiveness dependent on lithology) | Medium | Medium | Yes |
| | | Groundwater Extraction and Treatment using Vertical Extraction Wells | ● Install a groundwater extraction and treatment system in the transition zone along the southeast portion of the site to intercept COCs from the upper source area, and provide hydraulic control as well as reduction of dissolved-phase COCs mass. It is assumed that extracted groundwater would be treated with an air stripper and discharged to a NPDES outfall.<br>● Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase. | ● Extraction of impacted groundwater for treatment would reduce the dissolved-phase VOCs mass, and also establish hydraulic control to minimize plume migration toward city well 18M.<br>● Much less amount of aquifer material requiring disposal compared to the trenching method. | ● System installation would requires 3-4 weeks of significant site disruption.<br>● Long-term structure and treatment system which would require regular OM&M.<br>● Fine grain nature of the transition zone soils may significantly reduce the effectiveness of this technology as a method of cleanup. | Medium (effectiveness dependent on lithology) | Medium | Medium | Yes |

**Table A-1.**
**ALCOA OLEAN SITE TECHNOLOGIES ANALYSIS**

**OLEAN, NEW YORK**

| RAO | | Option | Design Basis and Assumptions | Advantages | Disadvantages | Short-term Effectiveness | Long-term Effectiveness | Relative Costs | Retained from Screening (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|
| Minimize the migration of COCs from the Site to the City Aquifer (Cont.) | Interception of Impacted Flow (Cont.) | Groundwater Extraction and Treatment using Horizontal Extraction Wells | • Install a groundwater extraction and treatment system in the transition zone below the Main Building to intercept COCs from reaching the City Aquifer. It is assumed that extracted groundwater would be treated with an air stripper and discharged to a NPDES outfall.<br>• Conduct Geotechnical Study.<br>• Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase. | • Extraction of impacted groundwater for treatment would reduce the migration of dissolved-phase VOC mass, to the City Aquifer and eventually toward city well 18M.<br>• Much less amount of aquifer material requiring disposal compared to the trenching method.<br>• The configuration of horizontal wells is more consistent with natural conditions, since groundwater transmissivity is generally greater in the horizontal, rather than the vertical direction. This may allow more efficient recovery of groundwater. | • The Vertical capture zone is limited and therefore has limited efficiency in capturing VOCs already present in the City Aquifer.<br>• System installation would requires 3-4 weeks of significant site disruption.<br>• Long-term structure and treatment system which would require regular OM&M.<br>• Fine grain nature of the transition zone soils may significantly reduce the effectiveness of this technology as a method of cleanup. | Medium (effectiveness dependent on lithology) | Medium | High | Yes |
| | | Permeable Reactive Barrier using Trenching Method | • Install a permeable reactive barrier (PRB) using zero valent iron (ZVI) perpendicular to groundwater flow along the eastern portion of the site, and add a few performance-monitoring wells which would require periodic sampling and upkeep.<br>• Assume the PRB would need to extend into transition zone of the city aquifer.<br>• Some subsurface utilities are present at the proposed trench location, but are anticipated to be easily identified and isolated.<br>• Assume the treatment zone would extend from 35 ft to 50 ft below ground surface (bgs) and be approximately 250 feet in length, effective ZVI thickness 1 foot.<br>• Assume trench would be installed using trenching method with use of biopolymer slurry.<br>• Assume the excavated materials from the top 35 feet can be used to re-fill trench without any need of treatment or off-site disposal, and the excavated materials below the top 35 feet could be disposed as non-hazardous waste (subtitle D facility) as indicated by the existing sampling data.<br>• Assume 6 new performance monitoring wells would be installed. | • No capital cost or ongoing operation and maintenance of treatment system<br>• PRBs constructed of ZVI have successfully treated cVOCs at a number of sites.<br>• Reportedly good longevity<br>• Increased iron concentrations in the groundwater typically do not extend more than a few feet downgradient of PRBs unless low pH conditions exist. | • The required thickness of the treatment zone is dependent on both COC concentrations and groundwater flow velocities, so a better understanding of concentrations and flow velocities needs to be developed prior to final selection of the PRB option.<br>• PRB installation would require 3-4 weeks of significant site disruption.<br>• May need to couple with a source removal option to shorten its operational life and reduce COC concentrations enough to allow full treatment.<br>• Need to address possible underflow issues.<br>• Disposal cost of trench soil as a result of PRB installation.<br>• The ZVI is placed using a biodegradable biopolymer slurry - an evaluation of any potential impacts to the city well water quality would need to be further evaluated prior to final selection of this remedy. | Medium to High | High | Low | No, Using Frac Rite is a more effective method |
| | | Permeable Reactive Barrier using Fracing Method | • Install a total of 36 frac boreholes (in two rows with borehole spacing of approximately 15 feet within each row) to a depth of 50 feet bgs.<br>• Within each borehole a total of 7 fractures will be created for ZVI emplacement, one fracture to be initiated every 2.5 feet from 50 feet bgs to 35 feet bgs.<br>• Assume 6 new performance monitoring wells would be installed. | • No capital cost or ongoing operation and maintenance of treatment system.<br>• PRBs constructed of ZVI have successfully treated cVOCs at a number of sites.<br>• Reportedly good longevity<br>• The fracing process generates a minimal amount of aquifer material requiring disposal. Some residual water/guar used in the injection mixing tanks may require off-site disposal. | • The required thickness of the treatment zone is dependent on both COC concentrations and groundwater flow velocities, so a better understanding of concentrations and flow velocities needs to be developed prior to final selection of the PRB option. The effective PRB ZVI thickness is only 3 inches in this alternative.<br>• PRB installation would requires 3-4 weeks of significant site disruption.<br>• May need to couple with a source removal option to shorten its operational life and reduce COC concentrations enough to allow full treatment.<br>• An evaluation of any potential impacts to the city well water quality would need to be further evaluated prior to final selection of this remedy. | medium | Mediurm to High | Low | Yes. However, the required thickness of the treatment zone is dependent on both COC concentrations and groundwater flow velocities, so a better understanding of concentrations and flow velocities needs to be developed prior to final selection of the PRB option. |
| | | Barrier Wall and Bottom Containment | • A L-shaped containment trench is installed down to the Upper Aquitard, positioned downgradient of groundwater flow around the Main Building.<br>• Horizontal wells will be installed beneath the Main Building to prevent vertical groundwater flow.<br>• The trench and wells will be filled with a bentonite slurry to contain the source area beneath the building.<br>• Conduct Geotechnical Study.<br>• Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase. | • No ongoing operation and maintenance of treatment system | • Installation would require 3-4 weeks of significant site disruption.<br>• Need to address possible around-flow issues.<br>• Disposal cost of trench soil as a result of barrier installation. | Medium to High | Medium | Medium | No, due to difficult implementability |
| | | Groundwater Sparging | • Install Horizontal Wells beneath the Site as conduit to deliver air to the source zone beneath the building.<br>• Deploy a shallow sub-slab depressurization system (SSDS) to control vapors should indoor air intrusion become an issue.<br>• Installation would be conducted in a phased approach during which supplemental investigation would be performed during the initial phase followed by full system installation during the final phase. | • Long horizontal screens contact a larger area of contaminated media, and effectively transmit additives associated with remedial activities (amendments, air, surfactants, etc.).<br>• Volatilization would reduce the dissolved phase VOC mass.<br>• Potential for additives to enhance biodegradation. | • Uncontrolled movement of potentially dangerous vapors.<br>• Enhanced biodegradation may lead to unwanted byproducts (e.g. vinyl chloride).<br>• Long-term structure and treatment system which would require regular OM&M.<br>• May need to couple with a source removal option to shorten its operational life. | medium | High | Medium | No, Not effective with lithology. |

**Table A-1.**
**ALCOA OLEAN SITE TECHNOLOGIES ANALYSIS**

**OLEAN, NEW YORK**

| RAO | | Option | Design Basis and Assumptions | Advantages | Disadvantages | Short-term Effectiveness | Long-term Effectiveness | Relative Costs | Retained from Screening (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|
| Minimize the migration of COCs from the Site to the City Aquifer (Cont.) | Sources in the Upper Aquitard | No Action | ● No remedial action is associated with this action.<br>● Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented. | ● No impact to wellhead treatment at 18M and/or 37/38M.<br>● No disruption to operations at the Cutco Facility.<br>● Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. | ● This action offers no reduction of toxicity, mobility, or volume through treatm | Low | Low | Low | Yes |
| | | Multiple ZVI Treatment Zones using Fracing Method | ● Install a total of 37 frac boreholes (in multiple rows with borehole spacing of approximately 20 feet within each row) to a depth of 28 feet bgs.<br>● Within each borehole a total of 8 fractures will be created for ZVI emplacement, one fracture to be initiated every 2.5 feet from 25.5 feet bgs to 8 feet bgs.<br>● Assume that the ZVI will last 10 years and that COC concentrations will be reduced to MNA levels in the fraced source areas.<br>● No new monitoring wells required for performance monitoring. | ● No capital cost or ongoing operation and maintenance of treatment system.<br>● Although this is a relatively new technique for increasing distribution in low hydraulic conductivity soils, the frac borehole locations cover the residual source area outside of the building (locations exhibiting TCE concentration above 10 ppm). The ZVI performance is well documented, but primarily requires the COCs to come in contact with the iron. Although the ZVI filled fractures will only be located in a portion of the aquifer volume, their higher hydraulic conductivity should cause groundwater to preferentially flow through them. Previous modeling efforts and head data suggest that impacted groundwater flows vertically down from the aquitard into the transition zone where predominately horizontal flow occurs towards the city well. Placement of multiple horizontal iron zones would treat the water as it moves through the aquitard and into the transition zone.<br>● The fracing process generates a minimal amount of aquifer material requiring disposal. Some residual water/guar used in the injection mixing tanks may require off-site disposal. | ● The residual sources underneath the building will not be treated, and would continue to impact the city aquifer. | Mediurm to High | Uncertain past 10 years | Low | Yes |
| | | In-Situ Chemical Oxidation with Persulfate or Permanganate | ● As success of this technique is heavily dependent on adequate distribution and soil oxidant demand, install boreholes with placement of sand followed by injection well installation due to the low soil permeability.<br>● Multiple injection events with strong oxidants such as permanganate or persulfate.<br>● No new monitoring wells required for performance monitoring. | ● Demonstrated success in many locations<br>● Effective for site-specific COCs<br>● Permanent injection wells allow re-injection of oxidants as needed | ● The residual sources underneath the building will not be treated, and could re-contaminate the treated volume and continue to impact the city aquifer as well.<br>● Changes in water chemistry as a result of chemical oxidation ultimately may reach city well 18m and require additional treatment. | Medium | Low | Medium | No, inability to reach bulk of source material under the building |
| | | In-Situ Chemical Oxidation with Ozone | ● As success of this technique is heavily dependent on adequate distribution and soil oxidant demand, install boreholes with placement of sand followed by injection well installation due to the low soil permeability.<br>● Multiple injection events with ozone<br>● No new monitoring wells required for performance monitoring. | ● Demonstrated success in many locations<br>● Effective for site-specific COCs<br>● Permanent injection wells allow re-injection of oxidants as needed<br>● Stronger oxidant than persulfate or permanganate. | ● The residual sources underneath the building will not be treated, and could re-contaminate the treated volume and continue to impact the city aquifer as well.<br>● The rapid reaction rate with ozone limits ozone transport over large distances. This results in a limited radius of influence around the injection point. | Medium | Low | Medium | No, inability to reach bulk of source material under the building |
| | | Enhanced Anaerobic Biodegradation | ● As success of this technique is heavily dependent on adequate distribution, install boreholes with placement of sand first followed by injection well installation due to the low soil permeability.<br>● Multiple injection events with an electron donor such as Edible Oil Sustrate (EOS), bioaugmentation may be required in some cases.<br>● No new monitoring wells required for performance monitoring. | ● Demonstrated success in many locations for site-specific COCs.<br>● Liquid electron donor is easier to distribute than ZVI.<br>● Permanent injection wells allow re-injection of electron donor as needed. | ● The residual sources underneath the building will not be treated, and could re-contaminate the treated volume and continue to impact the city aquifer as well.<br>● Use of organic carbon-rich electron donor could potentially impact the operation of city water treatment facility treating extracted groundwater from well 18M (i.e., need additional treatment of the increased BOD/COD in groundwater). | Medium | Low | Medium | No, inability to reach bulk of source material under the building |

**Table A-1.**
**ALCOA OLEAN SITE TECHNOLOGIES ANALYSIS**

**OLEAN, NEW YORK**

| RAO | | Option | Design Basis and Assumptions | Advantages | Disadvantages | Short-term Effectiveness | Long-term Effectiveness | Relative Costs | Retained from Screening (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|
| Minimize the migration of COCs from the Site to the City Aquifer (Cont.) | Sources in the Upper Aquitard (Cont.) | Groundwater/Dual Phase Extraction | • Install a dual-phase groundwater extraction and treatment system within the source area of the Upper Aquitard. It is assumed that extracted groundwater would be treated with an air stripper and discharged to a NPDES outfall. | • Extraction of impacted groundwater for treatment would reduce the residual contaminant mass in the Upper Aquitard, and hence reduce the impact to the underlying city aquifer. | • Although we were unable to review any actual performance data, information provided for this review indicate that some form of vacuum enhanced recovery was attempted at the site but was unsuccessful. Performance of such systems in this type of lithology is often marginal.<br>• Improved performance might be achievable using the frac placement describe for injecting amendments, but long-term structure and regular O&M would be required. | Low | Low | High | No, due to limited effectiveness |
| | | Electrical Resistance Heating | • Place electrodes in the subsurface throughout the target remediation area, and resistance to the flow of electrical current between electrodes would result in heating of the targeted soil.<br>• Removal of contaminants would be achieved by increased volatilization and in-situ steam stripping.<br>• Vapors containing contaminants would be collected for treatment. | • Very effective in removing VOCs mass even in low permeability heterogeneous lithologies, if site conditions/operations were to allow the deploment of this technology, treatment areas would probably reach MNA level within 2 years. | • Implementation of this alternative is very site disruptive. It would require closing off the treatment zone for up to a year and pose several significant safety issues for on-going plant operations.<br>• The residual sources underneath the building will not be treated, and would continue to impact the city aquifer. | High | High | High | No, due to the impact on OPS/owner (i.e., significant site disruption) |
| Address Dissolved Phase Plume in Upper Aquitard South of the Site | | No Action | • No remedial action is associated with this action.<br>• Reviews will be performed on a 5-year basis to determine if additional remedial actions should be implemented. | • No impact to wellhead treatment at 18M and/or 37/38M.<br>• No disruption to operations at the Cutco Facility.<br>• Implementation poses no risks to workers or the community and environmental impacts will remain as they are presently. | • This action offers no reduction of toxicity, mobility, or volume through treatm | Low | Low | Low | Yes |
| | | In-Situ Chemical Oxidation with Permanganate | • Install 170 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.<br>• Inject 500 gallons of 2% potassium permanganate per injection point.<br>• Assume three rounds of injection (one every year), and full-scale implementation for the first two injection events while 50% for the third injection event.<br>• Install 3 new monitoring wells for performance monitoring.<br>• Assume 3 years for cleanup. | • Demonstrated success in many locations.<br>• Effective for site-specific COCs.<br>• It is anticipated that the alternative will cause reduction of COC levels to MNA achievable levels within 3 years, no permanent structure will be left in place that needs regular operation and maintenance.<br>• Semi-annual performance monitoring would be conducted during the first yea and annual performance monitoring would be conducted during the following two years. | • A multi-week yearly injection event will cause some site disruption for an anticipated 3-year period | Medium to High | Medium to High | Low | No, due to effect on Groundwater Chemistry |
| | | In-Situ Chemical Oxidation with Persulfate | • As success of this technique is heavily dependent on adequate distribution and soil oxidant demand, install 17 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.<br>• Multiple injection events with strong oxidants persulfate.<br>• No new monitoring wells required for performance monitoring. | • Demonstrated success in many locations<br>• Effective for site-specific COCs<br>• Permanent injection wells allow re-injection of oxidants as needed | • Changes in water chemistry as a result of chemical oxidation ultimately may reach city well 18M or 37/38M and require additional treatment. | Medium to High | Medium to High | Low | Yes |

**Table A-1.**
**ALCOA OLEAN SITE TECHNOLOGIES ANALYSIS**

**OLEAN, NEW YORK**

| RAO | Option | Design Basis and Assumptions | Advantages | Disadvantages | Short-term Effectiveness | Long-term Effectiveness | Relative Costs | Retained from Screening (Yes/No) |
|---|---|---|---|---|---|---|---|---|
| Address Dissolved Phase Plume in Upper Aquitard South of the Site (Cont.) | In-Situ Chemical Oxidation with Ozone | ● As success of this technique is heavily dependent on adequate distribution and soil oxidant demand, install 17 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.<br>● Multiple injection events with ozone<br>● No new monitoring wells required for performance monitoring. | ● Demonstrated success in many locations<br>● Effective for site-specific COCs<br>● Permanent injection wells allow re-injection of oxidants as needed<br>● Stronger oxidant than persulfate or permanganate. | ● The rapid reaction rate with ozone limits ozone transport over large distances. This results in a limited radius of influence around the injection point. | | | Low | Yes |
| | Enhanced Anaerobic Biodegradation | ● Install 170 temporary injection points (in multiple rows with borehole spacing of approximately 10 feet within each row) to a depth of 20 feet bgs.<br>● Inject 500 gallons of 1% EOS amendment per injection point.<br>● Assume three rounds of injection (one every two years), and full-scale implementation for the first two injection events while 50% for the third injection event.<br>● Install 3 new monitoring wells for performance monitoring.<br>● Assume 6 years for cleanup. | ● Demonstrated success in many locations.<br>● Effective for site-specific COCs.<br>● It is anticipated that the alternative will cause reduction of COC levels to MNA achievable levels within 6 years, no permanent structure will be left in place that needs regular operation and maintenance.<br>● Semi-annual performance monitoring would be conducted during the first yea and annual performance monitoring would be conducted during the following five years. | ● A multi-week injection event every two years will cause some site disruption for an anticipated 6-year period | Medium to High | Medium to High | Low | No, due to the impact on wellhead treatment |
| | Groundwater/Dual Phase Extraction | ● Install a groundwater extraction and treatment system within the Upper Aquitard. It is assumed that extracted groundwater would be treated with an air stripper and discharged to a NPDES outfall (only to be considered if the city aquifer plume hydraulic control system is installed). | ● Extraction of impacted groundwater for treatment would reduce the residual contaminant mass, and hence shorten the time required to achieve MNA levels | ● Performance of such systems in this type of lithology is often marginal.<br>● Requires permanent extraction wells connected with underground piping that runs back to the treatment system at the facility. Periodic operation, maintenance and monitoring would require access to off-site landowners property. | Low to Medium | Low to Medium | High | No, due to the impact on OPS/owner (i.e., significant site disruption) |
| | Monitored Natural Attenuation | ● Install 3 new monitoring wells for performance monitoring.<br>● Assume 8 quarterly MNA monitoring events during the first two years, complete modeling and evaluation prior to full-scale MNA remedy.<br>● Assume annual MNA monitoring events after the first two years.<br>● Assume 30 years for cleanup. | ● No capital cost or ongoing operation and maintenance of treatment system<br>● Demonstrated success in many locations for site-specific COCs.<br>● Groundwater conditions in RU-8 generally favorable to MNA (e.g., presence of cis-1,2-DCE and vinyl chloride). | ● It may take over 30 years before reaching cleanup levels.<br>● It is assumed that as a result of city well 18M operation, there is no flow vector toward the target treatment area from the residual source area, but this may be subject to change in the future. | Low to Medium | Medium | Low | Yes |