DRAFT
FEASIBILITY STUDY REPORT

Site:
Country Cleaners
410 West Main Street
Huntington, New York 11743
Site No. 152187

Submitted to:
New York State Department of Environmental Conservation (NYSDEC)
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1 INTRODUCTION

This report presents the results of a Feasibility Study prepared by AECOM Technical Services Northeast, Inc. (AECOM) of alternatives for the environmental remediation of the Country Cleaners, Huntington, New York, located in Suffolk County. The Country Cleaners Site is listed as a Class 2 site on the New York State Department of Environmental Conservation (NYSDEC) Registry of Inactive Hazardous Waste Sites, Site No. 152187. The general location of the site is presented on Figure 1-1.

1.1 Background

In response to documented groundwater contamination at the site, NYSDEC commissioned a Remedial Investigation/Feasibility Study (RI/FS) for groundwater. The objective of the RI was to characterize the nature and extent of contamination of groundwater and to provide data for completing the FS. The scope of work for the RI is described in the final dynamic work plan submitted in May 2008, which incorporated NYSDEC comments on the proposed scope of work. The RI included a qualitative risk assessment to identify potential risks to human health and the environment due to contaminants present on site. The results of the RI (Draft Remedial Investigation Report, Country Cleaners, Huntington, Suffolk County, NY; AECOM, August 2010) are summarized in, and serve as the basis for, this FS report. The locations of the monitoring wells and general site features are presented on Figure 1-2.

1.2 Report Organization

The purpose of the FS is to identify and evaluate technologies that are available to remediate the contaminated groundwater as identified in the RI. The technologies most appropriate for the site conditions are then developed into Remedial Action Alternatives that are evaluated based on their environmental benefits and cost. The information presented in the FS will be used by NYSDEC to select on-site remedial action(s). The remedial action(s) selected for the site will be summarized by NYSDEC in a Proposed Remedial Action Plan (PRAP), which will be released for public comment. After receipt of public comments, NYSDEC will issue a Record of Decision (ROD).

The FS is organized in accordance with the outline provided in Section 4.4 of DER-10 (NYSDEC, 2010):

1. Introduction
2. Site Description and History
3. Summary of Remedial Investigation and Exposure Assessment
4. Remedial Goals and Remedial Action Objectives
5. General Response Actions
6. Identification and Screening of Technologies
7. Development and Analysis of Alternatives (assembly of a technologies into alternatives, evaluation of alternatives, and evaluation of institutional/engineering controls for the selected remedy)

8. Recommended Remedy and Rationale for Selection

Additional supporting material is provided in the Appendices.

AECOM completed the following scope of work for the FS, in accordance with DER-10 Guidance and the May 2008 final dynamic work plan incorporating NYSDEC comments.

2 SITE DESCRIPTION AND HISTORY

2.1 Site Description

The site is located at 410 West Main Street in Huntington, NY at the southeast corner of the intersection of West Main Street and Hillside Avenue. The site contains a single occupancy building. The site is located in a mixed commercial and residential area in Huntington, New York. The site consists of a single story building with parking spaces in the front. Residences are located in the surrounding areas. There is a large residential complex (Nathan Hale condominiums) located north of the site. Commercial properties are located along West Main Street, including a Getty service station to the east of the site, a Rite Aid convenience store, and a medical doctor’s office. St. Patrick’s Roman Catholic Church and primary school are located east of the site.

2.1.1 Topography

The site property is located at 110 ft above mean sea level (amsl), sloping to the northeast toward Huntington Harbor. The surrounding area peaks to the west of the site at approximately 180 ft amsl.

2.1.2 Surface Water Hydrology

The site is located approximately 1.5 miles east of Cold Spring Harbor and approximately 1.3 miles southwest of Huntington Harbor. The site is not located in an area mapped as either a 100 year or 500 year flood zone (FEMA, 2010). Surface drainage from the site generally follows topography, flowing toward the municipal storm drains located on West Main Street. A sewage disposal facility is located adjacent to Huntington Harbor.

2.1.3 Groundwater Hydrology

Groundwater at the site was encountered at 57 ft bgs, and is interpreted to flow northeast towards Huntington Harbor. According to the potentiometric surfaces of the upper glacial aquifer, Magothy aquifer, and Lloyd aquifer prepared by the United States Geological Survey (USGS, 1995), groundwater flow in the Huntington, NY area is generally towards the north.

2.1.4 Local and Site Geology

Recent deposits (0 to 20 ft bgs) consist of sand, gravel, silt and clay, organic mud, peat, loam and shells. Colors are brown, yellow and gray. Upper Pleistocene deposits (0 to 300 ft bgs) consist of the following: till (clay, sand and boulders as ground moraine in the area north of the Harbor Hill terminal moraine), outwash deposits (brown well stratified sand and gravel), and ice contact deposits (crudely stratified sand and gravel and isolated masses of till). The colors are pale to yellowish brown. Below these formations, are the Magothy formation, the Raritan formation clay member (aquitard) and Lloyd sand member overlaying bedrock (USGS, 1964).

2.2 Site History

Dry cleaning operations have been conducted at the site since at least 1985 by Jim Dandy Cleaners and previous tenants including Country Cleaners and Pamper Cleaners. Jim Dandy Cleaners currently leases the building at the site. According to the manager, Jim Dandy Cleaners does not currently use chlorinated VOCs having ceased its dry cleaning operations at the site around 2007. The site was listed as Class 2 in 2003.

The disposal of tetrachloroethene (perchloroethylene, or PCE) at the site has led to the contamination of on-site soil and groundwater, and off-site groundwater above the applicable NYSDEC standards. Information was gathered from a site investigation conducted at the Getty station located adjacent to the site, sampling by Suffolk County Department of Health Services (SCDHS), and NYSDEC.

Lou Halperin Properties, Inc. contracted Berninger Environmental, Inc. (BEI) to perform a limited subsurface investigation at the Getty Service Station property. PCE was detected in one monitoring well (MW-2) installed on the Getty Service Station property at 2,170 µg/L and TCE at 398 µg/L. BEI attributed the presence of chlorinated VOCs PCE and TCE to Country Cleaners.

Sampling at the Country Cleaners site was conducted by SCDHS starting in 1997. One source of contamination is located in a narrow yard at the south side of the property. PCE impacts were found in the soil beneath a condensate pipe at the southeast corner of the on-site building and in a nearby storm drain. In October 1997, soil samples were collected from the rear of the site. The PCE concentration in sludge collected in the area near the boiler blow down was 12,000 mg/kg.

Subsequent to the October 1997 investigation, SCDHS conducted a second round of investigation at the site in March 1998. PCE was detected at a concentration of 0.72 mg/kg, 9.3 mg/kg, 1.6 mg/kg, and 0.44 mg/kg in the soil samples collected at the site. PCE was detected at a concentration of 3,500 µg/L in the groundwater sample collected from a well located on the Getty Service Station property (MW-2), TCE at 65 µg/L, and cis-1,2 DCE at 450 µg/L.

Impact Environmental (Impact) performed additional sampling of the Country Cleaners site for SCDHS in 2000. The investigation included four borings from which soil headspace readings were obtained at multiple intervals. Headspace concentrations collected from three soil borings on the south side of the site ranged up to 2,000 ppm at 13-16 ft bgs. Impact also installed one new monitoring well, MW-1, in the southern portion of the site. The PCE concentrations in groundwater were 1,888 µg/L (MW-1) and 2,853 µg/L (Getty Service Station well MW-2); TCE and cis-1,2-DCE were also detected. Impact Environmental reported that PCE was detected at concentrations of 0.01 mg/kg and 0.031 mg/kg in the soil samples collected.

Under the order and oversight of the SCDHS, the owner remediated the storm drain in December 2001. Approximately 1,000 gallons of oily water and 36 tons of contaminated soil/sediments were removed to a depth of 26 ft bgs. An unknown quantity of soil was also removed from the unpaved portions of the yard. Subsequent sampling confirmed that PCE contamination remains in a location near the southeast corner of the building. An old floor drain was also found in the floor of the boiler room during the course of the investigation. NYSDEC was unable to conduct a thorough evaluation of the floor drain and associated piping because the new boiler was located directly over the drain. NYSDEC believes that this floor drain represents a possible point of past discharges contributing to the contaminated groundwater originating from the site.

Indoor air sampling was conducted in August 2003 by the New York State Department of Health (NYSDOH) at two structures. The samples were collected using a passive organic vapor monitoring badge and analyzed for PCE. At the structure on Hillside Avenue, PCE was identified as present at a concentration less than 5 $\mu g/m^3$ in the indoor air. At the structure on Scudder Avenue, PCE was identified as present at a concentration less than 5 $\mu g/m^3$ on the first floor and at concentrations of 12 $\mu g/m^3$ and 13 $\mu g/m^3$ in the basement air.

3 SUMMARY OF RI AND EXPOSURE ASSESSMENT

This section summarizes the findings of the RI conducted at the site and documented in AECOM (2010). The remedial investigation was conducted to determine the sources of contamination within the site and its threat to human health or the environment. The scope and execution of the RI is discussed below. The work to date consisted of three main efforts:

- Membrane interface probe investigation (July 2008)
- Hydropunch – screening level investigation (September 2008 and February 2009; Triad/dynamic work plan approach)
- Groundwater monitoring well installation and sampling (December 2009 – February 2010)

The MIP borings were advanced to collect remote sensing data indicating the possible presence of chlorinated VOCs in the soils or groundwater based on the response of the ECD. No samples were collected for laboratory analysis during the initial phase of the investigation.

Hydropunch groundwater and soil samples were collected from reoccupied MIP boring locations using direct push drilling in 2008 and early 2009. Groundwater and soil samples were analyzed for VOC analysis. The Hydropunch data were used as a screening tool to determine the appropriate screened interval for permanent monitoring well installation.

During monitoring well installation in December 2009 and January 2010, AECOM collected two soil samples for TOC and grain size analysis. Groundwater samples collected from the monitoring wells in 2010 were analyzed for VOCs.

3.1 Geology and Hydrogeology

The Long Island aquifer system lies within the Atlantic Coast Plain physiographic province, and is bounded on the north by the Long Island Sound and on the east and south by the Atlantic Ocean and on the west by New York Bay and the East River. The geologic formations of Long Island are composed of unconsolidated glacial deposits of Pleistocene age, and coastal plain deposits of continental and marine origin of Cretaceous age. The unconsolidated deposits consist of gravel, sand, silt, and clay underlain by bedrock of Lower Paleozoic and/or Precambrian age, which forms the base of the groundwater reservoir. Ronkonkoma terminal moraine (crudely stratified sand, gravel, and boulders; some till) forms an irregular ridge which runs to the west across Huntington. The west and Half Hollow Hills extend south through central and southern Huntington. Harbor Hill end moraine is present in the southern portion of Huntington.

Soil borings were advanced in the vicinity of the Country Cleaners site. Soil was generally classified as fine to medium sand with varying amounts of silt and gravel. A thick clay layer at an elevation of approximately 5 ft amsl was encountered throughout the site during installation of the deep wells. These soils are consistent with the Pleistocene deposits.

Long Island groundwater is present in three major aquifers: the Upper Glacial aquifer (shallow), the Magothy aquifer (intermediate), and the Lloyd Aquifer (deep). The uppermost hydrogeologic unit consists of Pleistocene saturated coarse sand and gravel and finer grained sand and gravel beds in the upper part of the Magothy formation. The lower limit of the shallow aquifer is identified by discontinuous clay bodies. The intermediate aquifer includes the Magothy formation to the top of the clay member of the Raritan formation. The deep aquifer is located within the sand member of the Raritan formation.

Groundwater level measurements were recorded on May 27, 2010 from the monitoring wells installed in December 2009 through January 2010 and the existing well MW-2. Both the deep and shallow wells are located in the shallow aquifer. Perched groundwater was identified in wells MW-3S/D, MW-4S/D, and MW-1S/D. A clay lens may be present at approximately 30 ft amsl. This clay layer may act as an aquiclude limiting vertical movement of the groundwater from the zone where the shallow wells are screened.

The groundwater elevation measurements were interpolated using inverse distance weighting for the shallow and deep wells separately. For both the shallow and deep wells the groundwater flow is towards the northeast. Groundwater flow patterns are consistent with those reported previously (USGS, 1964).

3.2 Nature of Contaminants Detected

The principle contaminants detected were chlorinated aliphatics. Principle chlorinated aliphatics include PCE and infrequent detection of the degradation products TCE and cis-1,2-DCE.

3.3 Extent of Contamination

The PCE groundwater plume is centered at the Country Cleaners site and neighboring Getty Service Center. The plume extends downgradient towards the northeast onto the Nathan Hale condominium property. The plume concentrations are expected to drop below the NYS Class GA groundwater criteria below the Nathan Hale property. There are no detections of PCE in the deep wells, indicating that the maximum depth of contamination has been adequately bounded.

3.4 Uncertainties in Nature and Extent of Contaminant Distribution

The identity of the contaminants is well-established, with data from collected from the permanent monitoring wells confirming findings from the MIP investigation and Hydropunch sampling in terms of compounds detected (PCE, TCE and DCE), and the spatial distribution of the contamination. The horizontal (areal) extent of contamination is not fully defined to the north and northeast where shallow wells on the Nathan Hale condominium property have concentrations exceeding the NYS Class GW groundwater criterion of 5 µg/L for PCE. The vertical extent of contamination is bounded, since PCE was not detected in any of the deep wells. However, the exact depth at which the PCE concentration falls below the NYS Class GA groundwater criterion is not known.

3.5 Contamination Transport

Groundwater flow is generally to the northeast. The process by which a solute (dissolved phase contaminant) is transported by the bulk movement of groundwater flow is referred to as advection. The average linear velocity of groundwater through a porous aquifer is determined by the hydraulic conductivity, effective porosity of the aquifer formation, and hydraulic gradient.

Adsorption of chlorinated aliphatics at the site may be an important process influencing the movement of contaminants in groundwater. The importance of adsorption depends significantly upon the characteristics of the aquifer matrix material, which acts as the adsorbing medium. In particular, adsorption of hydrophobic organic compounds has been shown to be a function of the amount of natural organic carbon in the aquifer matrix. PCE has an organic carbon partition coefficient (K_{oc}) of 200 and, therefore, will be adsorbed/retarded to a degree.

The estimated seepage rates range from 30 ft/yr to 41 ft/yr. The contaminated groundwater would reach the nearest known Suffolk County Water Authority well S-26681 between 119 and 163 years from the time of the release. The Country Cleaners plume is likely to have dissipated from dispersion and dilution prior to reaching S-26681, resulting in no significant impacts on the well. The point at which the plume is expected to decrease below the NYS Class GA groundwater criteria is beneath the Nathan Hale condominiums near MW-8S. Clay layers and lenses within the shallow aquifer may act as a barrier, limiting the spread of the groundwater plume. Additionally, S-26681 is screened in the deep aquifer (-485 ft amsl to -557 ft amsl; Lloyd Sand). The clay member of the Raritan formation may act as an additional barrier preventing transport of the PCE contaminated groundwater plume to this well.

3.6 Contaminant Fate

The fate of organic chemicals in the subsurface environment is affected by a variety of physiochemical and biological processes. Abiotic transformations such as hydrolysis, oxidation, and volatization are not significant factors in contaminant fate. Biodegradation is the one process which may have reduced PCE concentrations as evidenced by the breakdown products detected infrequently in groundwater samples within the plume. However, review of data collected from three shallow wells across the PCE plume indicates that biological transformation is currently not active at an appreciable rate.

3.7 Human Health Risk Assessment

A qualitative human health risk assessment was completed for the site. Generally, the human health evaluation involves an exposure assessment, an evaluation of site occurrence, hazard identification and comparison to Federal and New York State criteria. Exposure scenarios were identified and evaluated based on analytical laboratory results of groundwater, subsurface soil and ambient air samples collected.

- Since the screen for the public water supply well in the direction of groundwater flow is located under a confining layer the potential for exposure to contaminants in the groundwater at the site is expected to be minimal under current conditions.
- Risks would exceed generally acceptable ranges associated with ingestion of untreated groundwater at the site due to high concentrations of PCE and other contaminants.
- Concentrations in the soil are below the screening levels.
- There is a potential for exposure to soil vapor inside of buildings based on the PCE detections from air samples collected by NYSDOH at two structures in the vicinity of the site.

4 REMEDIAL GOALS AND REMEDIAL ACTION OBJECTIVES

4.1 Remedial Goals

For the State Superfund program, the default goal is to restore the site to pre-disposal conditions, to the extent feasible. According to 6 NYCRR Part 375-2.8, “The goal of the remedial program for a specific site is to restore that site to pre-disposal conditions, to the extent feasible. At a minimum, the remedy selected shall eliminate or mitigate all significant threats to the public health and to the environment presented by contaminants disposed at the site through the proper application of scientific and engineering principles and in a manner not inconsistent with the national oil and hazardous substances pollution contingency plan as set forth in section 105 of CERCLA, as amended as by SARA.”

Per ECL Article 27 Title 13, "The goal of any such remedial program shall be a complete cleanup of the site through the elimination of the significant threat to the environment posed by the disposal of hazardous wastes at the site and of the imminent danger of irreversible or irreparable damage to the environment caused by such disposal."

4.2 Remedial Action Objectives

This section presents the objectives for remedial actions that may be taken to protect human health and the environment. To develop the remedial action objectives (RAOs), AECOM identified contaminants present in the environmental media in the study area; evaluated existing or potential exposure pathways in which the contaminants may affect human health and the environment; identified pathways having a moderate to high likelihood for exposure; identified chemical-specific SCGs that apply to the likely exposure routes to establish the contaminants of concern and proposed cleanup goals for purposes of remediation; and established RAOs for the contaminants of concern to reduce the potential for future exposure. RAOs are presented for the environmental media in the study area, based on the generic NYSDEC RAOs contaminants of concern and SCG Goals.

4.2.1 Generic RAOs

The generic RAOs identified in DER-10 for groundwater will be applied to this site. The generic RAOs for groundwater are as follows:

RAOs for Public Health Protection

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

RAOs for Environmental Protection

- Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to surface water.
- Remove the source of ground or surface water contamination.

4.2.2 Standards, Criteria and Guidelines (SCGs)

The applicable Standards, Criteria and Guidelines (SCGs) for the site are described below. SCG selection is based on the following:

- The current, intended and reasonably anticipated future use of the site and its surroundings (mixed residential and non-residential);
- All contaminants exceeding applicable SCGs (PCE, TCE, and cis-1,2-DCE);
- The environmental media impacted by the contaminants exceeding the SCGs (groundwater);

- The extent of the impact to the environmental media;
- All actual or potential human exposures and/or environmental impacts resulting from the contaminants in environmental media; and
- No site-specific human health or environmental SCGs.

Chemical-specific SCGs are typically technology or health-risk based numerical limitations on the contaminant concentrations in the ambient environment. They are used to assess the extent of the remedial action required and to establish cleanup goals for a site. Chemical-specific SCGs may be directly used as actual cleanup goals, or as a basis for establishing appropriate cleanup goals for the contaminants of concern at a site. Chemical-specific SCGs for groundwater at the site are identified in Table 4-1.

Action-specific SCGs are usually administrative or activity-based limitations that guide how remedial actions are conducted. These may include record-keeping and reporting requirements; permitting requirements; design and performance standards for remedial actions; and treatment, storage and disposal practices. Action-specific SCGs identified for the site are provided in Table 4-2.

Location-specific SCGs apply to sites that contain features such as wetlands, floodplains, sensitive ecosystems, or historic buildings that are located on, or in close proximity to the site. Based on the RI, wetlands, floodplains, sensitive ecosystems or historic buildings are not located on, or in close proximity to the site. Thus, no location-specific SCGs were identified for this site.

4.2.3 Contaminated Groundwater Exposure Pathways

Exposure to groundwater, if used as a drinking water supply, includes ingestion, dermal contact and inhalation of vapors. Public water supply wells are located downgradient, the closest is about 4,865 feet away from the site. Low levels of chlorinated VOCs have been detected in down gradient public wells during periodic sampling conducted by SCDHS.

Groundwater flows approximately in a north-easterly direction, towards the Huntington Harbor. Potential human exposure may occur at the point of groundwater contact. The likelihood of exposure to groundwater due to construction activities is considered to be low since the groundwater is generally encountered at 52 ft amsl (approximately 58 ft bgs) in the shallow aquifer and approximately 80 ft amsl (approximately 30 ft bgs at the site) for perched groundwater. Potential human exposures include ingestion, dermal contact, and inhalation of vapors. Ingestion of groundwater (as drinking water), dermal contact and vapor inhalation scenarios are potential future exposure scenarios.

Potential human exposures to subsurface soils include ingestion, dermal contact, and inhalation under the future development scenarios with excavation.

4.2.4 Contaminants of Concern and SCGs

Tables 3-1 and 3-2 list the contaminants detected in samples collected on site and the chemical-specific SCGs (risk-based exposure limits) that apply to the likely exposure routes for the environmental media of interest. Proposed cleanup goals for each contaminant were developed in accordance with the procedures described below.

Proposed SCGs for organic compounds were selected by identifying the chemical-specific SCGs appropriate to the likely exposure pathways. The cleanup SCG was then selected based on the potential exposure scenarios and contaminated media encountered within the study area.

Contaminants of concern were identified for on-site environmental media by identifying the contaminants that exceeded the proposed cleanup SCGs and then evaluating the frequency that cleanup goals were exceeded and the relative toxicity of the contaminant. In general, contaminants of concern were established based on the exceedance of SCGs, frequency of detection, and being site-related.

The contaminants exceeding the applicable chemical-specific SCGs were identified in the groundwater only. These contaminants are PCE, TCE, and cis-1,2-DCE with the extent as described in Section 3.3 of this document. The groundwater flow direction is generally to the northeast toward Huntington Bay. This water body is classified as SA – saline water wildlife protection. Of the contaminants of concern in groundwater, there is only a class SA criterion for TCE at 40 µg/L. Concentrations of TCE in the groundwater from the Country Cleaners site as characterized by the RI would not exceed the class SA criteria, having a maximum detected concentration of 8 µg/L. Potential impacts to surface waters such as the Huntington Bay are not considered for this FS.

Source removal activities were conducted at the sight under the oversight of the SCDHS in 2001. As described in Section 2.2, the owner remediated the storm drain removing approximately 1,000 gallons of oily water and 36 tons of contaminated soil/sediments to a depth of 26 ft bgs; and an unknown quantity of soil from the unpaved portions of the yard. It is assumed that the majority of source contaminants at the dry cleaner have been removed. Therefore, no RAOs addressing source removal at the dry cleaner are considered in the FS.

As stated in the RI, indoor air samples were collected by NYSDOH at two residences in the vicinity of the site. No significant risks to human health were identified by NYSDOH. Therefore, RAOs addressing elevated VOC concentrations in soil vapor will not be considered in this FS.

4.2.5 Selected Remedial Action Objectives

This subsection presents the proposed RAOs to reduce the potential for future exposure. The RAOs for the site are:

1. Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards (PCE – 5 µg/L, TCE – 5 µg/L, and 1,2-cis-DCE – 2 µg/L), to the extent feasible.

2. Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable.

5 GENERAL RESPONSE ACTIONS

In keeping with the requirements of DER-10, the general response actions based on the RAOs for this site were developed with the following considerations:

- Include an estimate of the areas and volumes for the contaminated groundwater.
- Are specific to the impacted medium, contaminants, and geologic characterization of the site;
- Eliminate technologies that are not appropriate for the site due to site-specific factors or constraints;
- Include non-technology specific categories;
- Give preference to presumptive remedies; and
- Consider the use of innovative technologies where available and applicable.

As described in the RI, the estimated area and volume of contaminated groundwater to assist in evaluating remedial alternatives are 3.8 acres and 9.1 million gallons (MG). The horizontal extent exceeding the 5 µg/L NYS Class GA groundwater criterion for PCE is shown on Figure 4-1. This area extends beneath Highway 25A.

The non-technology specific remedial categories defined in Section 4.1 of DER-10 are as follows:

- Removal and/or treatment
- Containment
- Elimination of Exposure
- Treatment of source at the point of exposure

Elimination of exposure is not considered further in this FS because groundwater is the sole source of water supply in the area.

Presumptive remedies defined in DER-15 (NYSDEC, 2007) for VOCs contamination in groundwater include containment and treatment responses. The presumptive remedies are as following:

- Extraction and Treatment
- Air Stripping
- Granular Activated Carbon
- Chemical/Ultraviolet (UV) Oxidation
- Separate-Phase Recovery
- Air Sparging
- In-Well Air Stripping (Groundwater Recirculation)

- Bioremediation

Separate-phase recovery is not considered in this FS because this technology is primarily used for petroleum hydrocarbon contamination and a separate phase of contamination was not observed in the groundwater samples.

The general response actions evaluated in this FS include the following:

- No action with Monitored Natural Attenuation
- Ex-situ treatment (air stripping, granular activated carbon (GAC), or chemical/ultraviolet (UV) oxidation)
- In-situ treatment (air sparging, in-well air stripping, enhanced bioremediation or chemical oxidation)
- Containment (extraction wells or physical barrier)
- Treatment of source at the point of exposure by installing air strippers at the two potentially impacted public wells

6 SCREENING OF TECHNOLOGIES

This section presents the results of the preliminary screening of the associated remedial technologies that may be used to control the contaminants of concern and to achieve the RAOs. The technologies associated with the general response actions have been evaluated during the preliminary screening on the basis of effectiveness and implementability. The purpose of the preliminary screening is to eliminate remedial technologies that may not be effective based on anticipated on-site conditions, or that cannot be implemented technically at the site; and, to more narrowly focus the list of alternatives that will be developed and evaluated in greater detail.

6.1 No Action/Monitored Natural Attenuation

No Action/Monitored Natural Attenuation involves taking no further action to remedy groundwater conditions at the site with the exception of conducting long term monitoring. Groundwater monitoring tracks the progress of natural attenuation of the contaminant plume. Maximum concentrations of PCE have fallen from over 2,000 ug/L in the late 1990s to 680 ug/L in 2010 indicating a half life of approximately 10 years. At that rate, the maximum concentration of PCE may fall below the NYS Class GA groundwater criterion of 5 ug/L after several decades. For this alternative, it is assumed that annual sampling for VOCs and MNA parameters would be conducted annually for at least five years in the existing wells, followed by a reduction in sampling frequency to every five years.

6.2 Ex Situ Treatment

This general response action involves aboveground treatment of groundwater removed from the subsurface and discharge/disposal of the treated effluent. It is assumed that extraction wells would be placed on the dry cleaner and/or Getty Service Station property. The groundwater would be extracted at a rate to create a capture zone in the area where the highest concentrations have been detected, i.e., beneath the dry cleaner and Getty Service Station property. The extraction rate and estimated contaminant concentration within the extracted groundwater would be factors in sizing the system. It is assumed that the treatment facility would be located behind the dry cleaner. Disposal of the treated water would comply with the requirements listed in TOGS 2.1.2. This could involve:

1. Treating the groundwater to the cleanup goals and discharging the treated water back into the site groundwater via injection or diffusion wells;
2. Treating the groundwater and discharging the treated water to the a stormwater sewer in conformance with State Pollutant Discharge Elimination System (SPDES) permit requirements; or
3. Treating the water sufficiently for discharge to the sanitary sewer system managed by the Huntington Publicly Owned Treatment Works (POTW).

It is assumed that the groundwater treatment technologies will remove VOC contamination to below the NYS Class GA groundwater criteria.

The following subsections describe the results of preliminary screening of technologies that were considered for ex situ treatment of groundwater.

6.2.1 Air Stripping

Air stripping involves passing air through the contaminated groundwater to induce volatilization and removal of VOCs. If necessary to comply with permit requirements, air that contains organic vapors stripped from the groundwater can be treated by either filtration with activated carbon, or another appropriate method prior to discharge to the atmosphere. Air stripping is most appropriate for situations where the contaminants to be treated are volatile and where there are no significant concentrations of dissolved metals that may precipitate (e.g., iron).

Effectiveness – Air stripping is expected to be an effective technology for treating the groundwater to less than the NYS Class GA groundwater criteria. This is a proven and reliable technology for treatment of water containing VOCs. A packed tower stripper could be used to treat the groundwater prior to discharge to the storm sewer or sanitary sewer system, or injected into the aquifer. Air emissions may need to be treated prior to discharge, based on the anticipated levels, for protection of human health and the environment, or compliance with an air emissions permit. Elevated levels of iron and manganese were detected in the groundwater samples collected for the RI. Therefore, pretreatment of the groundwater for metals may be required.

Implementability – The labor, equipment and materials for installation of an air stripper at the site are readily available. Air emissions from the stripper may require treatment by activated carbon, or appropriate method to meet NYSDEC requirements for allowable concentrations of PCE and other VOCs in air.

The process equipment that would be required to implement an air stripping treatment system includes construction of a shelter building, an electrical power source, instrumentation and controls system equipment, an equalization tank to receive influent water from the groundwater extraction well, potential metals treatment process (e.g., greensands filter), an air stripper unit with an air blower, an off gas treatment system to remove organic vapors from air prior to discharge to the atmosphere, activated carbon for polishing of the groundwater, and discharge piping for effluent water leading to the existing stormwater sewer system. In addition, effluent discharge and SPDES permits will be required from NYSDEC, which should be attainable. Alternatively, the treated water could be discharged to the sanitary sewer. However, the fees associated with disposal to the sanitary sewer may be prohibitive. The system will need to substantially comply with appropriate State and Federal air permit requirements. Once the system is operational, typically, limited maintenance of the system is required.

Air stripping appears to be an effective and implementable technology for ex situ treatment of contaminated groundwater prior to discharge, when used in conjunction with other technologies for pre-treatment and post-treatment of the effluent. Ex situ treatment by air stripping is retained for further evaluation in this FS.

6.2.2 Granular Activated Carbon

Liquid phase carbon adsorption is used to remove organic compounds from groundwater by adsorbing the organic compounds onto the surface of granular activated carbon. Water is treated as it flows through the granular activated carbon. Granular activated carbon can be packed into a treatment column or placed in properly sized drums or pressure vessels connected in series. On a regular basis, the granular activated carbon must be changed since its adsorption capacity is depleted with use.

Effectiveness – Use of carbon may be an effective method of primary groundwater treatment of groundwater. However, the carbon usage rate for groundwater treatment is expected to be high, particularly during initial startup when higher flow rates are anticipated. Thus, significant quantities of activated carbon are anticipated to be consumed, that would result in the need for frequent carbon change-out. Carbon may also be utilized in a treatment process for the purposes of final polishing following the use of one of the other treatment technologies. Disposal of the spent carbon and system maintenance related to the carbon change-outs would be required.

Implementability – Granular activated carbon treatment columns or containers are readily available and relatively simple to install and replace.

This technology is retained as a potential secondary treatment to be used in conjunction with air stripping.

6.2.3 Ex Situ Oxidation

Ex situ oxidation processes include the use of ultraviolet (UV) radiation, ozone, or hydrogen peroxide to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect or escape.

UV oxidation is a destruction process that oxidizes organic and explosive constituents in water by the addition of strong oxidizers and irradiation with UV light. Oxidation of target contaminants is caused by direct reaction with the oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone and/or hydrogen peroxide. If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts. The main advantage of UV oxidation is that it is a destruction process, as opposed to air stripping or carbon adsorption, for which contaminants are extracted and concentrated in a separate phase. UV oxidation processes can be configured in batch or continuous flow modes, depending on the throughput under consideration.

UV oxidation differs from UV photolysis, a related process but one which does not typically fully convert organic contaminants to carbon dioxide, hydrogen peroxide, and salts (chlorides in the case of chlorinated compounds).

For the discussion below, oxidation by UV radiation in conjunction with peroxide is assumed.

Effectiveness – Ex situ oxidation is effective at remediating sites with chlorinated aliphatic contamination. Ex situ treatment is not hindered by subsurface heterogeneities that affect in situ options. Organic compounds with double bonds (e.g., TCE, PCE, and vinyl chloride) are rapidly destroyed in UV/oxidation processes. However, ex situ oxidation is subject to the same limitations as all pump and treat options, in that complete remediation may be time-consuming and often becomes ineffective or inefficient as the final remediation criteria are approached.

Implementability – Ex situ oxidation is readily implemented. It requires groundwater extraction and pumping to a treatment location, followed by discharge of treated water. Remediation systems capable of treating as much as 1,000,000 gpd have been installed. Issues related to UV/oxidation include:

- The influent may require treatment to provide for good transmission of UV light (high turbidity causes interference). This factor can be more critical for UV/hydrogen peroxide than UV/ozone. (Turbidity does not affect direct chemical oxidation of the contaminant by hydrogen peroxide or ozone).
- Free radical scavengers can inhibit contaminant destruction efficiency. Excessive dosages of chemical oxidizers may act as a scavenger.
- The aqueous stream to be treated by UV/oxidation should be relatively free of metals (less than 10 mg/L) to minimize the potential for fouling of the quartz sleeves.
- Some VOC contaminants may be volatilized (e.g., “stripped”) rather than destroyed; therefore, off-gas treatment (by activated carbon adsorption or catalytic oxidation) may be necessary.

Ex situ oxidation is retained for further evaluation in the FS.

6.3 In Situ Treatment

6.3.1 Air Sparging

The technology of air sparging involves contaminant reduction primarily by volatilization and biodegradation. Sparging is conducted by injecting air into the subsurface below the water table under controlled pressure and volume. Contaminants, such as dissolved phase chlorinated aliphatics in the groundwater and adsorbed onto soil are volatilized (or stripped) when in contact with the injected air. Air containing stripped contaminants migrates upward through the groundwater into and through the unsaturated zone, where it is ultimately collected in vacuum/vapor extraction wells, in order to capture volatilized chemicals prior to discharge into the atmosphere. The air is then treated and discharged to the atmosphere.

In addition to the stripping process that occurs on contaminants in the groundwater, it has been shown that air sparging provides for enhanced biodegradation under certain conditions. However, PCE is degraded anaerobically in the subsurface environment. Therefore, sparging is not expected to significantly enhance biodegradation of site contaminants.

Effectiveness - This technology is generally effective in removal of VOCs from groundwater, especially highly volatile compounds such as chlorinated VOCs. The effectiveness of this technology is based in part on the site geology. Higher removal efficiencies are generally accomplished in coarse-grained soils, as airflow channels are more evenly distributed both laterally and vertically. However, subsurface heterogeneities may inhibit the sparged air from contacting dissolved phase contamination in groundwater. Air sparging is anticipated to reduce VOC concentrations (by approximately one order of magnitude), but is not believed to be able to meet the groundwater remediation objective for PCE (5 µg/L).

Implementability – An air sparging system is potentially implementable at the site, although the layout of the injection wells and vapor extraction wells would need to consider current land usage (e.g., presence of Highway 25A within the footprint of the plume). The materials, equipment and labor for installation of a sparging system are available and can be readily implemented. Sparge wells can be reliably installed to the required depth and the screened interval can be installed to meet the subsurface conditions. The system requirements include a blower/air compressor system, and a vapor extraction/treatment system. Pilot testing may be necessary to evaluate the required design parameters (e.g., sparge well spacing, injection flow rate, etc.), relative to the desired remediation of chlorinated aliphatics in groundwater. Installation of the vapor extraction system typically requires at least 5 ft of unsaturated thickness in the overburden aquifer.

Air sparging may achieve groundwater concentrations below the NYS Class GA groundwater criterion for PCE. However, this technology is eliminated from further consideration in this FS due to the potential for vapor migration.

6.3.2 In-Well Air Stripping (Groundwater Recirculation)

The in-well groundwater circulation well system creates in situ vertical groundwater circulation cells by drawing groundwater from the aquifer through the lower screen of a double-screened well and discharging it through the second screen (upper) section. While groundwater circulates in and out of the stripping cell, no groundwater is removed from the ground. Air is injected into the well through a gas injection line and diffuser, releasing bubbles into the contaminated groundwater. These bubbles aerate the water and form an air-lift pumping system (due to an imparted density gradient) that causes groundwater to flow upward in the well. As the bubbles rise, VOC contamination in the groundwater is transferred from the dissolved state to the vapor state through an air stripping process. Groundwater may be polished at the well head through carbon adsorption or injection of a chemical oxidant prior to recirculation.

The air/water mixture rises in the well until it encounters the dividing device within the inner casing. The divider is designed to maximize volatilization. The air/water mixture flows from the inner casing to the outer casing through the upper screen. A vacuum is applied to the outer casing, and contaminated vapors are drawn upward through the annular space between the two casings. The partially treated groundwater re-enters the subsurface through the upper screen and infiltrates back to the aquifer and the zone of contamination where it is eventually cycled back through the well, thus allowing groundwater to undergo sequential treatment cycles until the remedial objectives are met. Off-gas from the stripping system is collected and treated (e.g., using granular activated carbon). Pilot testing and field measurements would be required to determine the exact well and piping configuration.

Effectiveness – The effectiveness of in-well recirculation is dependent on the groundwater velocity and the contaminant concentrations within the treatment zone along with the air injection rate. The greater the concentrations and velocities, the more recirculation wells will be required along the axis of groundwater flow. A pilot test would be required prior to full scale implementation.

Implementability – For the subsurface conditions at the site, recirculation wells are an implementable technology to treat the plume and prevent further migration of the plume. The materials, equipment, and labor necessary to install extraction wells are readily available. Fouling of the system may occur by precipitation of oxidized constituents. The technology is not recommended for sites with lenses of low-conductivity deposits which may be present in this aquifer. Wells and screens must be placed to prevent spreading the contamination. Treatment is likely to require a long period of time to achieve the RAOs.

In-well recirculation will not be considered further due to limited available data on performance, and possible fouling of the system from elevated iron levels measured in the site groundwater.

6.3.3 Enhanced Bioremediation

Enhanced bioremediation refers to the addition of substrates, microbes, and/or electron acceptors to the groundwater through injection wells.

Effectiveness – Bioremediation can be effective for the destruction of chlorinated VOCs in groundwater; and a properly designed enhanced bioremediation system can be effective at the complete oxidation of chlorinated VOCs. The effectiveness of bioremediation could be tested prior to implementation using biotraps as an alternative to pilot or bench testing.

Implementability – Enhanced bioremediation is implementable but is limited by the presence of active businesses and the highway. To counter these impediments, injections could target the area of the plume with highest measured concentrations and a line of injections could be installed north of Highway 25A to create a barrier to contaminant migration for PCE from the portion of the plume extending below the highway.

Enhanced bioremediation is retained for further evaluation as a potential remedial technology in this FS.

6.3.4 Chemical Oxidation

In situ chemical oxidation is a technology whereby an oxidant is injected into an aquifer or subsurface soils. Common oxidants include peroxide, ozone, and permanganate. These compounds cause rapid and complete chemical destruction of many organic chemicals. The process includes placing injection points throughout the area to be treated, and injection of the selected oxidant into the aquifer/subsurface.

Effectiveness – High treatment efficiencies have been demonstrated for unsaturated aliphatics. Chemical oxidants are capable of oxidizing chlorinated VOCs such as PCE.

Implementability – Implementation of this technology is limited by the presence of active businesses and the highway. Injections could target the area of the plume with highest measured concentrations. The materials, equipment and labor necessary to implement this technology are available from several vendors.

Application of an in situ oxidant appears to be a reasonable approach for the treatment of source area contamination beneath the dry cleaner and Getty Service Station. Use of this technology to treat the high concentration areas is retained in this FS and will be considered further in the detailed analysis.

6.4 Containment

6.4.1 Groundwater Extraction

Groundwater extraction is a commonly used method to control the migration of contaminated groundwater and to collect contaminated groundwater for subsequent (ex situ) treatment. Groundwater extraction wells are generally installed with a drill rig. Well screens and filter packs are generally installed to intercept the saturated thickness of the contaminated water-bearing zone. Extraction wells can be installed to provide a hydraulic barrier for control of migration of contaminated groundwater, or at specific locations for source area remediation.

Effectiveness – Groundwater extraction wells are an effective remedy that could be used in conjunction with other technologies to meet the RAOs. Extraction wells, in conjunction with an ex situ groundwater treatment system, would reduce the mobility, toxicity, and volume of contaminated groundwater. Extraction wells can be installed with limited site disturbance and relatively low potential for impacts to human health and the environment during installation, as compared to other technologies that are more intrusive. Extraction wells are a proven and reliable technology for removal of groundwater for remediation.

Implementability – Complete capture of the plume may not be practical. The soil in the aquifer is predominantly sand with gravel. The hydraulic conductivity is likely to be at least 175 ft/day. For this aquifer, the pumping rate to achieve a capture zone extending throughout the plume is likely to be in excess of 1,000 gpm. There are limitations on well placement due to the existence of active businesses and a highway. The materials, equipment and labor necessary to install extraction wells are readily available. Extraction wells can be reliably installed to the required depth and the screened interval can be installed to meet the subsurface conditions.

Groundwater extraction for containment is not considered further in this FS due to limitations on well placement which are likely to prohibit the complete capture of the plume. Groundwater extraction with ex situ treatment is retained assuming the highest concentrations of PCE in groundwater can be targeted.

6.4.2 Physical Barriers

The purpose of groundwater containment is to restrict the flow of contaminated groundwater. This is generally accomplished by a physical barrier (slurry wall, sheet piling), hydraulic control (removing water from the ground, such as by pumping from extraction wells), or reactive barriers. Containment technologies that rely on groundwater extraction are occasionally supplemented with a low permeability subsurface barrier wall to improve the effectiveness of the extraction system. Another groundwater containment technology includes groundwater collection trenches, which are constructed for the purpose of collecting groundwater.

Effectiveness – Physical barriers could contain the contaminated groundwater. A thick clay layer was identified at approximately 100 ft bgs. A geotechnical study would be required. Long term monitoring to document the effectiveness of the technology would be recommended.

Groundwater extraction wells may be used to exert hydraulic control to prevent the migration of the groundwater. Prior to the design of such a system a thorough analysis of the aquifer properties including pump tests would need to be performed to ensure an adequate array of extraction wells are installed. The extracted groundwater would be routed to in an ex situ treatment unit.

Implementability – While construction of physical barriers is possible, significant disruption to the community is anticipated, e.g. construction noise in the immediate vicinity of a large residential community. Current land use would limit placement of the barrier walls.

Groundwater extraction wells are an implementable technology for exerting hydraulic control to prevent further migration of the plume. The materials, equipment, and labor necessary to install extraction wells are readily available.

Physical barriers will not be considered further in this FS due to limits on placement.

6.5 Treatment at Downgradient Public Wells

Two public wells are located downgradient from the site. The locations of public wells known to exist in the area are shown on Figure 6-1. Although levels of chlorinated VOCs are currently below the NYS Class GA groundwater criteria, treatment of the extracted groundwater may be required in the future. The extracted groundwater could be treated prior to distribution by an air stripper, GAC, or UV oxidation.

Effectiveness – Air stripper, GAC, or UV oxidation can effectively remove PCE from groundwater to achieve the RAOs. Additional technologies may be required in pre-treatment of influent or post-treatment of the effluent.

Implementability – Materials and labor are readily available. Operation and maintenance (O&M) costs vary depending on the selected technology.

Treatment at the public wells is retained for further evaluation.

7 DEVELOPMENT AND ANALYSIS OF ALTERNATIVES

Based on the technology review and screening (as summarized in Section 6.3), four remedial alternatives have been developed for the remediation of contaminated groundwater. The selected alternatives include presumptive remedies specified in DER-15. These alternatives include readily available technologies which have been proven to be effective at similar sites with VOC contamination in groundwater.

The selected alternatives include:

Alternative 1 – No action/monitored natural attenuation
Alternative 2 – Groundwater extraction and ex situ treatment
Alternative 3 – In situ treatment
Alternative 4 – Groundwater treatment at downgradient public wells/ monitored natural attenuation

7.1 Remedial Action Alternatives

As described above, site remedial action alternatives have been assembled using general response actions and remedial technologies that passed the preliminary screening. An expanded description of each of the alternatives is provided below. The following information is provided for each alternative:

- Size and configuration of process options
- Time for remediation
- Spatial requirements
- Options for disposal
- Substantive technical permit requirements
- Limitations or other factors necessary to evaluate the alternatives
- Beneficial and /or adverse impacts on fish and wildlife resources
- Cost

Capital costs, O&M costs, and present worth costs were estimated for each alternative. All direct and indirect capital costs and engineering costs for the construction of all facilities and process equipment, labor, materials, construction equipment and services were estimated for the alternatives. The estimates included herein assume contingencies, engineering costs, project management costs, and construction management. Costs for system start up and testing, facility operation, maintenance and repair, continuous performance and effectiveness monitoring, and periodic site condition reviews were estimated. A present worth analysis is made to compare the remedial alternatives on the basis of a single dollar amount for the base year. For the present worth analysis, assumptions are made regarding the interest rate applicable to borrowed funds and the average inflation rate. The period of performance evaluated for cost estimations does not exceed 30 years. For the Alternative 1, a review of the data after 30 years would determine if further monitoring is necessary. It is assumed that any construction is performed in 2012 and completed in that year. Cost sheets are provided in Appendix A. Supporting information (calculations and vendor information) is provided in Appendix B.

7.1.1 Alternative 1 – No Action/Monitored Natural Attenuation

Alternative 1 would involve taking no further action to remedy site conditions, other than to perform groundwater monitoring. This alternative allows for natural attenuation of impacted groundwater. NYSDEC guidance requires that the No Action alternative be considered in the detailed analysis of alternatives.

This alternative assumes that annual groundwater monitoring would be conducted every year for five years then every five years. The 15 existing wells shown on Figure 1-2 would be sampled using low flow sampling. All wells would be sampled for VOCs by EPA method 8260 and water levels in the wells would be measured. Three of the groundwater samples would also be analyzed for monitored natural attenuation parameters. Costs also include an environmental easement/deed restriction and preparation of a report summarizing the monitoring data following each sampling event.

Size and configuration of process options - Not applicable.

Time for remediation - It is anticipated that the groundwater concentrations would remain above the NYS Class GA groundwater criteria for decades since the half life of PCE in groundwater appears to be on the order of ten years.

Spatial requirements - Not applicable.

Options for disposal - Not applicable.

Substantive technical permit requirements – No permit requirements were identified for this alternative.

Limitations or other factors necessary to evaluate the alternatives – No limitations or other factors necessary to evaluate the alternative were identified.

Beneficial and /or adverse impacts on fish and wildlife resources – No beneficial and/or adverse impacts to fish and wildlife resources were identified.

Cost - A cost estimate is provided in Appendix A. The costs for this option are: capital costs of $51,000, present worth O&M costs for 30 years of $673,000, and total present worth for 30 years of $727,000.

7.1.2 Alternative 2 – Groundwater Extraction and Ex Situ/Monitored Natural Attenuation

This alternative would implement groundwater extraction for ex situ treatment by air stripping as the primary treatment. Other treatment alternatives are viable, but this technology is selected for evaluation as representative of ex situ treatment options. Air stripping uses volatilization to transfer contaminants from groundwater to air. In general, water is contacted with an air stream to volatilize dissolved contaminants into the air stream. Depending on the level of contaminants in the air discharge, the contaminated air stream may need further treatment. This alternative would includes pre-treatment (filtering) to address elevated iron and manganese levels in the groundwater prior to air stripping. The treated groundwater would comply with the NYS Class GA groundwater criteria. No treatment is included for the air effluent. If necessary, the facility would be heated adequately to allow year-round operation. Costs also include an environmental easement/deed restriction and preparation of a report summarizing the monitoring data.

Figure 7-1 presents a conceptual layout of Alternative 3. It is assumed that field testing would be conducted during a pre-design study to better define the radius of influence and capture zone of the wells and optimize the location of the extraction and injection wells. It is assumed that the testing would be completed using the existing wells. The extraction well(s) would be screened within the impacted aquifer approximately 20 to 50 feet amls. It is assumed that the extraction system would consist of two wells. The extent of the capture zone may be limited due to the relatively high hydraulic conductivity of the aquifer and limitations on locating the extraction wells because of current land use. It is assumed that the treatment system would extract and treat groundwater from the most highly contaminated region of the plume and the remainder would be subject to monitored natural attenuation.

The groundwater treatment system would consist of an equalization tank, bag filters, an air stripper, and an effluent holding tank. The treatment system would be located on-site in a new structure located behind the dry cleaner.

Periodic groundwater sampling would be required to evaluate the effectiveness of the treatment. Groundwater sampling would be conducted as described for Alternative 1 every year for five years then at ten, 20, and 30 years from the time the treatment started.

Size and configuration of process options - For an influent flow rate of 200 gpm, a packed tower with a 36” diameter and a 25 ft packing depth is assumed. The groundwater would be filtered (bag filter) initially to address elevated metals concentrations. No treatment of the air effluent is assumed.

Time for remediation - Reduction of PCE concentrations in the source area to the SCGs is expected within the first two or three years of treatment. The remainder of the plume is expected to attenuate within 30 years.

Spatial requirements – The treatment facility is expected to be approximately 6 ft by 8 ft. The extraction wells would be flush mounted. Land on the dry cleaner and Getty Service Station property would be disturbed during construction for installation of the wells and to install the piping and electrical conduit below ground surface.

Options for disposal – Because the treated groundwater would comply with NYS Class GA groundwater criteria, disposal to the local POTW, storm drains, or re-injection to the aquifer are viable options. For costing, it is assumed that the treated groundwater is partially re-injected to the aquifer and the remainder is discharged to the nearest stormwater catch basin.

Substantive technical permit requirements - The air releases must comply with the substantive requirements of DAR-1. However, this system is exempt for state air permit requirements because the work is performed at a State Superfund site, but would comply with the substantive requirements of state and federal permits. The underground injection/recirculation system must comply with the substantive requirements of a SPDES permit and the NYS Class GA groundwater criteria. Discharge to the stormwater catch basis must comply with the substantive requirements of a SPDES permit.

Limitations or other factors necessary to evaluate the alternatives – This alternative assumes a stormwater catch basin is present in the area surrounding the dry cleaner for disposal of a portion of the groundwater effluent. A field test using the existing wells would be conducted in pre-design to provide field measurements to better define the radius of influence and capture zone for the extraction wells.

Beneficial and /or adverse impacts on fish and wildlife resources – No beneficial and/or adverse impacts to fish and wildlife resources were identified.

Cost - A cost estimate is provided in Appendix A. The costs for this option are: capital costs of $403,000, present worth O&M costs for 30 years of $587,000, and present worth for 30 years of $1,017,000.

7.1.3 Alternative 3 – In Situ Treatment/Monitored Natural Attenuation

This alternative would implement in situ treatment by enhanced bioremediation as the primary treatment. Chemical oxidation would be applied as a secondary treatment because the chemical oxygen demand and biological oxygen demand measurements for this aquifer are low. These in situ treatments would be used to reduce PCE levels in the area under the dry cleaner and Getty Service Station property where the highest PCE levels were detected. Additionally, a downstream barrier would be implemented north of Highway 25A to capture contamination migrating to the northeast. It is assumed a pre-design pilot study would be conducted. Costs also include an environmental easement/deed restriction and preparation of a report summarizing the monitoring data.

Size and configuration of process options - Injections would be made on approximately a 15 ft grid (25 injections) from 50 ft amsl to 20 ft amsl on the dry cleaner and Getty Service Station properties. The barrier injections would be installed at approximately 15 ft intervals (nine points) from 50 ft amsl to 20 ft amsl on the driveway of the Nathan Hale property located just north of Highway 25A. The proposed injection locations are shown on Figure 7-2.

For Alternative 3, injections to promote bioremediation and chemical oxidation in the source area would be performed, see Appendix B for an example of product information. For bioremediation, injection of a micro-emulsion is proposed. The micro-emulsion would provide free lactic acid, controlled release lactic acid and long release fatty acids for effective hydrogen production. This application provides cost-effective anaerobic treatment of contaminants in groundwater. In addition, a chemical oxidant would be applied to these 23 source area injection sites. A second polishing injection of chemical oxidants would be conducted. In the barrier wells, only the micro-emulsion is injected into the temporary wells.

Periodic groundwater sampling would be required to evaluate the effectiveness of the treatment. Groundwater sampling would be conducted as described for Alternative 1 every year for five years then at ten, 20, and 30 years from the time the treatment started.

Time for remediation - Reduction of PCE concentrations in the source area to SCGs is expected within the first two to three years from of the initial time of application. The remainder of the plume is expected to attenuate within 30 years.

Spatial requirements – Not applicable.

Options for disposal – Not applicable.

Substantive technical permit requirements – The remediation would need to meet the requirements of an EPA Underground Injection Control (UIC) Program. Roadway opening permits would not be required because the injections are located on private property.

Limitations or other factors necessary to evaluate the alternatives – The area of the plume where injections can be made is limited to the dry cleaner, Getty Service Station, and portions of the Nathan Hale property.

Beneficial and /or adverse impacts on fish and wildlife resources – No beneficial and/or adverse impacts to fish and wildlife resources were identified.

Cost - A cost estimate is provided in Appendix A. The costs for this option are: capital costs of $440,000, present worth O&M costs for 30 years of $504,000, and present worth for 30 years of $974,000.

7.1.4 Alternative 4 - Groundwater Treatment at Downstream Public Wells/Monitored Natural Attenuation

This alternative would provide treatment at the two public wells (S-71533 and S-26681) located downgradient from the site as shown on Figure 6-1. PCE concentrations in these wells do not currently exceed the NYS Class GA groundwater criterion. If selected, this alternative would be implemented in the event PCE concentrations consistently exceeded NYS Class GA groundwater criterion for PCE or daughter products. For cost estimations, the construction of the air strippers is assumed to occur in 2012. Well productions rates are 650 gpm for S-71533 and 1,500 gpm for S-26681. Although PCE can be treated by a number of technologies, for this alternative analysis it is assumed that an air stripper will be installed as the primary removal technology because long term O&M requirements are relatively low. Long term monitoring would be implemented at the site since groundwater contamination remains at the site. The monitoring is the same as described for Alternative 1. Costs also include an environmental easement/deed restriction and preparation of a report summarizing the monitoring data.

Size and configuration of process options – For the 650 gpm supply well, a packed tower 72" diameter with a 12 ft packing depth is assumed. For the 1,500 gpm supply well, a packed tower 96" diameter with a 12 ft packing depth is assumed. No water filtration or treatment of the effluent air is assumed.

Time for remediation – groundwater concentrations would remain above the NYS Class GA groundwater criteria for more than 30 years.

Spatial requirements – Approximately 6 ft by 8 ft is required for the air stripper and associated equipment.

Options for disposal- Not applicable.

Substantive technical permit requirements – No permit requirements were identified for this alternative. Air releases from a treatments system for a public well supply are exempt from DAR-1 permit requirements.

Limitations or other factors necessary to evaluate the alternatives – The layout of the public water well facilities is not known. It is assumed that there is adequate space available for implementation of this alternative at the well facilities.

Beneficial and /or adverse impacts on fish and wildlife resources – No beneficial and/or adverse impacts to fish and wildlife resources were identified.

Cost - A cost estimate is provided in Appendix A. The costs for this option are: capital costs of $460,000, present worth O&M costs for 30 years of $1,259,000, and present worth for 30 years of $1,750,000.

7.2 Detailed Analysis of Alternatives – General

The purpose of the detailed analysis of remedial action alternatives is to present the relevant information to select an on-site remedy. During the detailed analysis, the alternatives established in Section 7.1 are compared on the basis of environmental benefits and costs using criteria established by NYSDEC in DER-10 (NYSDEC, 2010). This approach is intended to provide needed information to compare the merits of each alternative and select an appropriate remedy that satisfies the RAOs for the site.

7.2.1 Description of Evaluation Criteria

The alternatives were evaluated against the following remedy selection evaluation criteria. Of these criteria, the first two are threshold criteria that must be satisfied in order for an alternative to be considered for selection. The remaining seven criteria are balancing criteria used to compare the positive and negative aspects of the alternatives. Community acceptance is evaluated after completion of the proposed remedial action plan by NYSDEC.

1 Overall Protection of Human Health and the Environment: This criterion is an evaluation of the ability of the alternative to protect public health and the environment; the ability of the alternative to eliminate, reduce or control any existing or potential human exposures or environmental impacts identified in the RI and to achieve the RAOs identified in Section 4. This assessment considers other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs.
2 SCGs: This criterion is used to evaluate the extent to which each alternative conforms to the SCGs identified in Section 4.
3 Long-Term Effectiveness and Permanence: This criterion addresses the long-term effectiveness and permanence of the alternative after implementation. If contamination remains after implementation, this criterion requires evaluation of human exposures, ecological receptors or impacts to the environment.
4 Reduction of Toxicity, Mobility, and Volume: This criterion is an evaluation of the ability of the alternatives to reduce the toxicity, mobility and volume of site contamination. Alternatives that permanently or significantly reduce the toxicity, mobility or volume of the contamination at the site are preferred.
5 Short-Term Impacts and Effectiveness: This criterion is an evaluation of potential short-term adverse environmental impacts and human exposures during construction or implementation of the alternative. Short-term impacts are conditions which may cause human exposures, adverse environmental impacts and nuisance conditions. Means of controlling short-term impacts are identified. The effectiveness of these controls is evaluated. Examples of short-term impacts include increased truck traffic, odors, vapors, dust, habitat disturbance, run off, and noise.
6 Implementability: This criterion evaluates the technical and administrative feasibility of implementing an alternative. Technical feasibility includes difficulties associated with construction and the ability to monitor the effectiveness of the alternative. Administrative feasibility includes the availability of the necessary personnel and material and potential difficulties in obtaining approvals, access, etc.
7 Cost Effectiveness: An evaluation of the overall cost effectiveness of an alternative. An assessment is made as to whether the cost is proportional to the overall effectiveness of the alternative.
8 Land Use: This criterion is an evaluation of the current, intended and reasonable anticipated future use of the site and its surroundings as it relates to the alternative when unrestricted levels are not achieved.
9 Community Acceptance: This criterion is evaluated after the public review of the remedy selection process as part of the final DER selection/approval of the remedy for the site.

7.3 Detailed Analysis of Site Alternatives

Alternatives No. 1 through 4 are evaluated individually in terms of the seven environmental and one cost criteria described above. Descriptions of the alternatives are provided in Section 7.1.

7.3.1 Alternative 1 – No Action/Monitored Natural Attenuation

1 Overall Protection of Human Health and the Environment: This alternative is not protective of human health and the environment, since the site would remain in its present condition. Groundwater can continue to migrate off site, potentially impacting the downgradient public wells.
2 Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: Reduction in PCE contamination below the chemical-specific SCGs for the site is expected in several decades assuming a 10-year half life for the contamination. No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) can be met during sampling activities.
3 Long-Term Effectiveness and Permanence: Because this alternative does not involve removal or treatment of the contaminated groundwater, the risks involved with the migration of contaminants and direct contact with contaminants remain essentially the same over a long period of time.
4 Reduction of Toxicity, Mobility, and Volume: This alternative does not involve the removal or treatment of the source of on-site contamination. Therefore, neither the toxicity, nor mobility, nor volume of contamination is expected to be reduced significantly. As the plume expands under this alternative the volume of groundwater with concentrations greater than the standards may increase for some time before eventually decreasing to below standards. Natural attenuation of contaminants is expected to reduce the concentration in groundwater over time.
5 Short-Term Impacts and Effectiveness: No short-term impacts are anticipated during the implementation of this alternative, since no construction activities involved, only sampling. Field personnel wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes is decontaminated prior to leaving the site, as needed, in order to avoid the transport of contaminants.
6 Implementability: This alternative is readily implementable. Groundwater sampling can be performed without sophisticated equipment, and the necessary services and equipment are readily available.
7 Cost Effectiveness: The present worth (30 year life) for this alternative is estimated to total approximately $727,000. This alternative does not effectively mitigate risk from contamination at the site, and the costs are lower than alternatives providing active remediation of treatment at the public wells.
8 Land Use: Institutional controls (e.g., deed or access restrictions) would be required for the on-site property to preclude contact with contaminated media (i.e., groundwater withdrawal or use restrictions).

7.3.2 Alternative 2 – Groundwater Extraction and Treatment/Monitored Natural Attenuation

1. Overall Protection of Human Health and the Environment: This alternative is considered to be protective of human health and the environment. Implementation of this alternative would result in remediation of groundwater. Although the alternative will not meet the SCGs throughout the site, this alternative for groundwater remediation is considered to be protective of human health since PCE concentrations in groundwater are expected to reach the chemical SCGs within 30-years.
2. SCGs: It is expected that this alternative will meet the chemical-specific SCGs for on-site groundwater between the source area and the downgradient property line within a 30-year timeframe. No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during construction activities.
3. Long-Term Effectiveness and Permanence: Chemical-specific SCGs are expected to be achieved within 30 years. Therefore, this alternative is considered an adequate and reliable remedy for mitigating human health and environmental impacts due to groundwater.
4. Reduction of Toxicity, Mobility, and Volume: The toxicity, mobility and volume of on-site groundwater contamination are expected to be reduced significantly through the use of extraction wells, ex situ treatment, and natural attenuation at the fringe of the plume.
5. Short-Term Impacts and Effectiveness: There are minimal short-term effects related to the installation and construction of this type of treatment system. Potential exists for worker exposure to contaminated groundwater during the installation of the extraction wells and during the startup of the system. Extraction well(s) will be installed by a drill rig. Workers and construction vehicles will be present on active businesses. Some flexibility in the work schedule (e.g., working weekends) may be required. Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the site, as necessary, in order to avoid the transport of contaminants.
6. Implementability: This alternative is readily implementable on a technical basis. Construction and installation of the groundwater extraction/treatment systems would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. With regard to O&M, the materials and services required for the systems are also readily available. Groundwater sampling can be performed without sophisticated equipment, and the necessary services and equipment are readily available.

   In terms of administrative concerns, this alternative is also considered to be implementable. Implementation of this alternative would require coordination with and approval by Town of Huntington agencies as well as coordination with the owners/occupants of the dry cleaner and Getty Service Station. However, no specific problems are anticipated in obtaining permits or approvals from the various agencies and other concerns. A thorough survey of utilities and piping traversing the properties would need to be conducted prior to the installation of the injection/extraction wells and the associated infrastructure.
7. Cost Effectiveness: The present worth for this alternative is estimated to total approximately $1,017,000. This alternative effectively mitigates risk from contamination at the site, and the cost is similar to the cost of the in situ remediation alternative.

8 Land Use: This alternative is expected to achieve the chemical-specific SCGs for this site within a reasonable timeframe. No changes to land use are anticipated.

7.3.3 Alternative 3 – In Situ Treatment by Chemical Oxidation/Monitored Natural Attenuation

1 Overall Protection of Human Health and the Environment: This alternative is considered to be protective of human health and the environment. Implementation of this alternative would result in remediation of groundwater within the area of higher contamination and create a barrier to contaminant migration at the northeast extent of the plume.
2 SCGs: This alternative is expected to meet the chemical-specific SCGs for on-site groundwater between the source area and the plume limits within a 30-year timeframe for the majority of the site areas. No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during construction activities.
3 Long-Term Effectiveness and Permanence: This alternative is considered an adequate and reliable remedy for mitigating human health and environmental impacts (in terms of affecting habitat or vegetation) due to groundwater. The injection of an oxidant has a potential to eliminate impacts within the region of the plume with highest PCE concentrations, allowing the lower concentrations of VOCs to further dissipate through bioremediation.
4 Reduction of Toxicity, Mobility, and Volume: The injections to promote bioremediation and chemical destruction through oxidant would immediately reduce the concentration of VOCs within the injected area. The injections will target groundwater impacts beneath the dry cleaner and Getty Service Station properties. Injections at the northeast extent of the plume create a barrier to migration by promoting bioremediation in this area; eventually reducing the toxicity and limiting mobility of the contaminated groundwater.
5 Short-Term Impacts and Effectiveness: Short-term impacts associated with the injected chemicals include risks to workers during handling of the solution. Injections will be accomplished with a drill rig. Workers and construction vehicles will be present on active businesses potentially causing some disruption. Some flexibility in the work schedule (e.g., working weekends) may be considered. Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the site, as necessary, in order to avoid the transport of contaminants.
6 Implementability: This alternative is readily implementable on a technical basis. Construction and installation of the injection systems would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. Several vendors supply the oxidants. Confirmatory groundwater sampling would be performed to monitor the effectiveness of injections. A pilot study may be implemented as part of pre-design work. Modification of the construction schedule to minimizing disruptions to the dry cleaner and Getty Service Station will be considered.
7 Cost Effectiveness: The present worth for this alternative is estimated to total approximately $974,000. This alternative effectively mitigates risk from contamination at the site, and the cost is similar to the cost of the ex situ remediation alternative.
8 Land Use: This alternative is expected to achieve the chemical-specific SCGs for this site within a reasonable timeframe (less than 10 years). No changes to land use are anticipated.

7.3.4 Alternative 4 – Groundwater Treatment at Downgradient Public Wells/Monitored Natural Attenuation

1 Overall Protection of Human Health and the Environment: This alternative is considered to be protective of human health from ingestion of groundwater extracted from the public wells. This alternative is not protective of human health and the environment in the vicinity of the site, since the site would remain in its present condition with gradual reduction of contaminant levels through natural attenuation.

2 Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: Groundwater extracted from the downgradient public wells will comply with the chemical-specific SCGs for the site. For groundwater at the site, reduction in PCE contamination below the chemical-specific SCGs for the site is expected in several decades. No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during sampling and construction activities.

3 Long-Term Effectiveness and Permanence: At the public wells, this alternative effectively mitigates risk to human health resulting from site-related contamination. At the site, the risks involved with the migration of contaminants and direct contact with contaminants would remain essentially the same over a long period of time.

4 Reduction of Toxicity, Mobility, and Volume: This alternative reduces the toxicity of groundwater extracted from the downgradient wells. This alternative does not involve the removal or treatment of the source of on-site contamination. Therefore, neither the toxicity, nor mobility, nor volume of contamination is expected to be reduced significantly. Natural attenuation of contaminants may reduce the concentrations in groundwater over time. Reduction of PCE contamination is expected within several decades.

5 Short-Term Impacts and Effectiveness: There are minimal short term effects related to the installation and construction of this type of treatment system. Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the site, as necessary, in order to avoid the transport of contaminants.

6 Implementability: This alternative is readily implementable on a technical basis. Construction and installation of the treatment systems would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. With regard to O&M, the materials and services required for the systems are also readily available. Also, the instrumentation and control systems will be automated with remote access capabilities, such that the effect of possible system shut-downs would be minimized. Groundwater sampling can be performed without sophisticated equipment, and the necessary services and equipment are readily available.

9 Cost Effectiveness: The present worth for this alternative is estimated to total approximately $1,750,000. This alternative effectively mitigates risk from contamination from the site at the two known public downgradient wells, but the cost is higher than all of the other remediation alternatives examined.

7 Land Use: Institutional controls (e.g., deed or access restrictions) would be required for the on-site property to preclude contact with contaminated media (i.e., groundwater withdrawal or use restrictions).

8 RECOMMENDED REMEDY AND RATIONALE FOR SELECTION

This section presents a comparative analysis of remedial alternatives and a recommended alternative. The alternatives are compared below on the basis of criteria defined in Section 7.2.1. The cost comparison is provided on Table 8-1, and the overall comparative analysis is summarized on Table 8-2.

8.1 Overall Protection of Human Health and the Environment

Alternative 2 and 3 are protective of human health and the environment. Alternatives 1 and 4 provide adequate protection of human health and the environment with regard to contaminated environmental media. Alternative 4 is protective of human health at the point of exposure.

8.2 SCGs

Alternatives 2 and 3 are expected to achieve substantial compliance with the chemical-specific SCGs/remediation action objectives for groundwater. Alternatives 1 and 4 are not expected to achieve compliance within 30 years. Alternative 4 achieves compliance with the chemical-specific SCGs at the point of exposure. Each of the alternatives evaluated is considered to be in compliance with action-specific SCGs; permits and approvals necessary for implementing these alternatives will be obtained prior to initiating the remedial action. No location-specific SCGs were identified.

8.3 Long-Term Effectiveness and Permanence

Alternatives 2 and 3 are considered to be adequate, reliable and permanent remedies for the remediation of groundwater. Alternatives 1 and 4 are not considered adequate, reliable, or permanent long-term remedies for groundwater at the site. However, Alternative 4 provides effective long term protection of human health from ingestion of water for the two known downstream public wells.

8.4 Reduction of Toxicity, Mobility, and Volume

Alternatives 2 and 3 provide for the reduction of toxicity, mobility and volume of impacted groundwater. Alternatives 1 and 4 are expected to provide for the reduction of toxicity, mobility and volume of impacted groundwater over an extended period of time (greater than 30 years). Alternative 4 provides for the reduction of toxicity of impacted groundwater at the point of exposure.

8.5 Short-Term Impacts and Effectiveness

No significant short-term impacts are identified for Alternatives 1 and 4. Alternatives 2 and 3 involve intrusive work which may provide some disruption of the dry cleaner and Getty Service Station during construction activities.

Alternative 1 is not effective at reducing risks from the groundwater contamination in the short-term. Alternatives 2 and 3 are expected to realize significant reductions in the groundwater contaminant levels within the first year after construction. Alternative 4 provides effective reduction in contaminant levels at the point of exposure after implementation of the systems.

8.6 Implementability

Alternatives 1, 2, 3, and 4 are technically implementable with readily available methods, equipment, materials, and services. Alternatives 1, 2, 3, and 4 are also administratively implementable. Property owners or tenants may object to the intrusive work required for Alternatives 2 and 3.

8.7 Cost Effectiveness

The estimated costs associated with the implementation of each alternative are summarized on Table 8-1. The lowest present worth cost of $727,000 is for Alternative 1 which does not include remedial actions for groundwater; rather, this alternative only includes long-term groundwater monitoring. Alternatives 2 and 3 are expected to provide effective remediation of groundwater. The present worth costs for Alternatives 3 and 4 are $1,017,000 and $974,000, respectively. The present worth cost for Alternative 4 is $1,750,000 which provides effective human health protection from ingestion of water for the two known downstream public wells, but does not effectively remediate the groundwater contamination at the site.

8.8 Land Use

Deed restrictions are required for Alternatives 1 and 4 because groundwater contamination is expected to remain above the NYS Class GA groundwater criteria for an extended period of time.

8.9 Recommended Alternative

Alternatives 2 and 3 are expected to meet the threshold criteria (protection of human health and the environment, and compliance with SCGs). Alternatives 1 and 4 do not meet the threshold criteria because elevated concentrations remain on site or in the vicinity of the site, slowly attenuating over time.

Both Alternatives 2 and 3 provide long-term effectiveness and permanence; reduction in the toxicity, mobility and volume of the contamination; and are implementable. Both alternatives require intrusive activities which may be disruptive to the owners or tenants at the dry cleaners and Getty Service Station. Both alternatives may require some pre-design data collection. The estimated costs for these alternatives are similar, differing by two percent. Both alternatives are expected to significantly reduce contaminant levels and do not require implementation of land use restrictions.

Alternative 3 is recommended because it is expected to provide a similar level of effectiveness as Alternative 2, but it provides a means of addressing downgradient contamination through installation of barrier injections as well as remediation in the source area. For Alternative 2, no equipment is left on-site or and periodic maintenance of equipment is not required. Although Alternative 3 is intrusive and potentially disruptive to the owners and tenants at the dry cleaner and Getty Service Station, the construction period is expected to be shorter than for Alternative 2 (approximately one week), and does not require trenching and repair of pavement, or coordination with government agencies for permit acquisition.

9 REFERENCES

AECOM Technical Services, Inc. (AECOM), 2010. Draft Remedial Investigation Report. Country Cleaners Site. August.

NYSDEC, 2007. Presumptive/Proven Remedial Technologies. February.

New York State Department of Environmental Conservation (NYSDEC), 2010. Technical Guidance for Site Investigation and Remediation. DER-10. Division of Environmental Remediation. May.

Table 3-1
Shallow Wells - Groundwater Concentration Summary Statistics

Parameter	CAS	Detection Frequency	Detection Limit Range	Minimum Detected Value	Maximum Detected Value	Maximum Detected Sample	NYSDEC Class GA Groundwater Criteria	Number of Exceed-ances	NYS MCL	Number of Exceed-ances	EPA MCL	Number of Exceed-ances
Shallow Wells												
VOCs (ug/L)												
Chloroform	67-66-3	1 / 8	1 - 5	3.3	3.3	MW-7S	7	0	50	0	80	0
cis-1,2-Dichloroethene	156-59-2	1 / 8	1 - 5	9.3	9.3	MW-4S	5	**1**	5	**1**	70	0
Tetrachloroethene (PCE)	127-18-4	6 / 8	1 - 5	1.1	680	MW-4S	5	**5**	5	**5**	5	**5**
Trichloroethene (TCE)	79-01-6	1 / 8	1 - 5	8	8	MW-2S	5	**1**	5	**1**	5	**1**
Inorganics-Total (ug/L)												
Iron	7439-89-6	3 / 3	150 - 150	200	500	MW-2S	300	**2**	300	**2**	NL	--
Manganese	7439-96-5	0 / 3	25 - 25	--	--	--	300	0	300	0	NL	0
Inorganics-Filtered (ug/L)												
Iron	7439-89-6	0 / 3	150 - 150	--	--	--	300	0	300	0	NL	0
Manganese	7439-96-5	0 / 3	25 - 25	--	--	--	300	0	300	0	NL	0
Shallow Hydropunch Samples												
VOCs (ug/L)												
2-Butanone	78-93-3	1 / 10	5 - 25	4.8	4.8	HP-16C	50	0	50	0	NL	--
Acetone	67-64-1	6 / 10	5 - 25	7.4	19	HP-16C	50	0	50	0	NL	--
Benzene	71-43-2	1 / 10	1 - 5	0.71	0.71	HP-16C	1	0	5	0	5	0
cis-1,2-Dichloroethene	156-59-2	3 / 10	1 - 5	13	41	HP-04B	5	**3**	5	**3**	70	0
Methyl tert-butyl Ether	1634-04-4	2 / 10	1 - 5	0.5	2.95	HP-02E	NL	--	10	0	NL	--
Tetrachloroethene (PCE)	127-18-4	6 / 10	1 - 5	0.58	1,500	HP-02E	5	**4**	5	**4**	5	**4**
Toluene	108-88-3	1 / 10	1 - 5	1.3	1.3	HP-16C	5	0	5	0	1000	0
trans-1,2-Dichloroethene	156-60-5	1 / 10	1 - 5	0.73	0.73	HP-04B	5	0	5	0	100	0
Trichloroethene (TCE)	79-01-6	4 / 10	1 - 5	9.8	36	HP-05B	5	**4**	5	**4**	5	**4**

Table 3-2
Deep Wells - Groundwater Concentration Summary Statistics

Parameter	CAS	Detection Frequency	Detection Limit Range	Minimum Detected Value	Maximum Detected Value	Maximum Detected Sample	NYSDEC Class GA Groundwater Criteria	Number of Exceed-ances	NYS MCL	Number of Exceed-ances	EPA MCL	Number of Exceed-ances
Deep Wells												
VOCs (ug/L)												
Methyl tert-butyl Ether	1634-04-4	2 / 7	0.5 - 0.5	0.51	0.58	MW-4D	NL	--	10	0	NL	--
Deep Hydropunch Samples												
VOCs (ug/L)												
1,1-Dichloroethane	75-34-3	1 / 16	1 - 5	1.1	1.1	HP-02G	5	0	5	0	NL	--
1,1-Dichloroethene	75-35-4	1 / 16	1 - 5	0.76	0.76	HP-02G	5	0	5	0	7	0
2-Butanone	78-93-3	2 / 16	5 - 25	4.15	5	HP-39D	50	0	50	0	NL	--
Acetone	67-64-1	2 / 16	5 - 25	11.5	24	HP-39D	50	0	50	0	NL	--
Benzene	71-43-2	2 / 16	1 - 5	0.67	0.81	HP-39E	1	0	5	0	5	0
Bromodichloromethane	75-27-4	1 / 16	1 - 5	1.2	1.2	HP-05C	50	0	50	0	80	0
Chloroform	67-66-3	10 / 16	1 - 5	0.56	2.3	HP-12C	7	0	50	0	80	0
cis-1,2-Dichloroethene	156-59-2	2 / 16	1 - 5	0.53	1.3	HP-33H	5	0	5	0	70	0
Dibromochloromethane	124-48-1	2 / 16	1 - 5	0.54	2.2	HP-05C	50	0	50	0	80	0
Methyl tert-butyl Ether	1634-04-4	2 / 16	1 - 5	1.3	1.4	HP-33I	NL	--	10	0	NL	--
Tetrachloroethene (PCE)	127-18-4	11 / 16	1 - 5	1.4	92	HP-33H	5	**5**	5	**5**	5	**5**
Toluene	108-88-3	2 / 16	1 - 5	1.095	1.1	HP-39D	5	0	5	0	1000	0
Trichloroethene (TCE)	79-01-6	7 / 16	1 - 5	0.71	2.8	HP-05C	5	0	5	0	5	0

Table 4-1
Chemical-Specific Standards, Criteria, and Guidance

Title	Citation	Description/applicability
Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations	6 NYCRR 700-706 Water Quality Regulations; especially Part 703.5; summarized in TOGS 1.1.1.	Groundwater (Class GA) standards and guidance values; applicable. Establishes long-term remediation goals. PCE: 5 ug/L, TCE: 5 ug/L, cis-1,2-DCE: 5 ug/L, and vinyl chloride: 2 ug/L
New York Public Water Supplies	10 NYCRR 5-1.52 (Tables); 10 NYCRR 170.4 (Standards for Raw Water)	Drinking Water standards; relevant. May be used where groundwater standard may not be protective of aquifer use for potable water supply. Principle Organic Contaminant Maximum Contaminant Level: 5 ug/L (Table 3)
Primary Drinking Water Regulations – Maximum Contaminant Levels	40 CFR 141.61	Establishes federal maximum contaminant levels for organic contaminants in drinking water; relevant where it addresses contaminants not included in state standards, or has more stringent criteria. PCE: 5 ug/L, TCE: 5 ug/L, cis-1,2-DCE: 70 ug/L, and vinyl chloride: 2 ug/L
Ambient (Surface Water) standards and guidance values	NYCRR 700-706; especially Part 701 (establishes water classes); 6 NYCRR 925 Table I (designates Huntington Bay as Class SA)	Surface Water Standards (Class SA); potentially applicable to discharge to Huntington Bay. PCE: none, TCE: 40 ug/L, cis-1,2-DCE: none, and vinyl chloride: none

GA Source of Drinking Water (groundwater)
SA Wildlife Protection (saline waters)

Table 4-2

Action-Specific Standards, Criteria, and Guidance

Title	Citation	Description/applicability
Hazardous Waste Regulations	6 NYCRR Part 370	Potentially applicable for off-site disposal of contaminated groundwater classified as hazardous waste
Solid Waste Regulations	6 NYCRR Part 360	Potentially applicable for off-site disposal of contaminated groundwater classified as hazardous waste
Selection of remedial actions at hazardous waste disposal sites	NYSDEC TAGM 4030	This TAGM provides guidelines to select an appropriate remedy at State Superfund sites, and sets forth a hierarchy of remedial technology treatments consistent with SARA and RCRA land disposal restrictions.
Guidelines for the Control of Toxic Ambient Air Contaminants	Air Guide 1	Potentially applicable for alternatives with discharges to air (e.g., air stripping)
Underground Injection/ Recirculation at Groundwater Remediation Sites	NYSDEC T.O.G.S. 2.1.2	Potentially applicable for alternatives involving re-injection of groundwater
Surface water standards	6 NYCRR 701.8 (best uses for Class C); 6 NYCRR 703.5; TOGS 1.1.1.	Potentially applicable for alternatives with discharges to surface water
Sanitary Sewer	Huntington Municipal Code §164 especially Article III, §164.16 Special agreements and arrangements	Potentially Applicable for alternatives with discharges to sanitary sewer system
Stormwater discharge permit	Environmental Conservation Law Article 17 Title 8; Implementing Regulations - 6nycrr Part 750; Huntington Municipal Code §170	Potentially applicable for discharges to stormwater sewer system

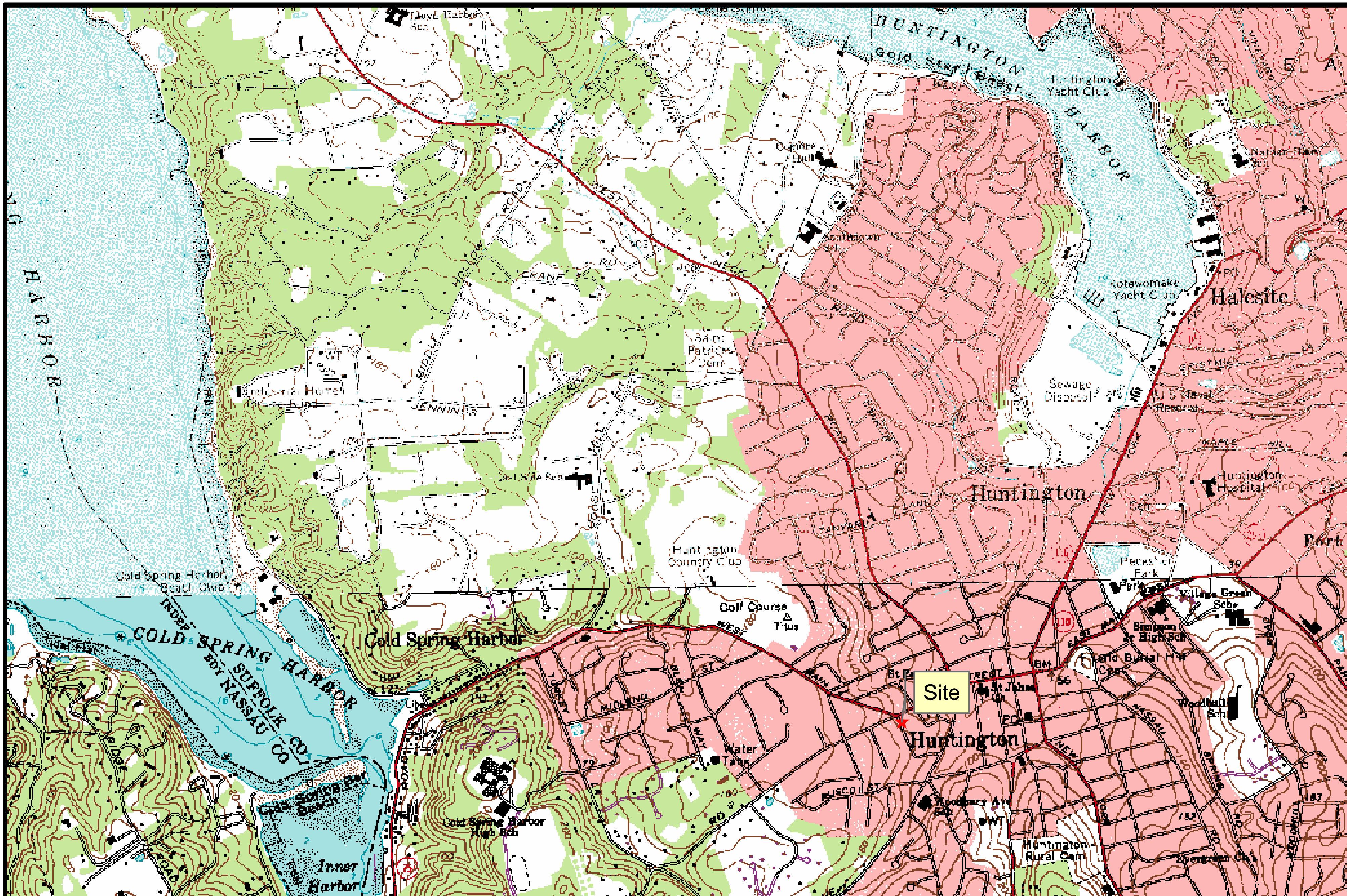
Table 8-1
Remedial Action Alternatives-Cost Estimate Summary

Summary of Costs	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Captial Costs				
Total Construction Cost	$45,000	$263,682	$287,778	$300,876
Contingencies (20%)	$2,250	$52,736	$57,556	$60,175
Engineering (15%)	$0	$39,552	$43,167	$45,131
Project Management (8%)	$3,600	$21,095	$23,022	$24,070
Construction Management (10%)	$0	$26,368	$28,778	$30,088
Total Capital Cost	$50,850	$403,433	$440,301	$460,340
Present Worth Capital Costs	$54,231	$430,254	$469,572	$490,944
Annual O&M Costs	$0	$0	$0	$0
Total Annual O&M Cost	$53,443	$122,186	$53,443	$69,773
Contingency (20%)	$2,672	$6,109	$2,672	$3,489
Project Management (8%)	$4,275	$9,775	$4,275	$5,582
Total Annual O&M Cost	$60,391	$138,070	$60,391	$78,843
Present Worth of O&M Costs (30 year life)	$672,863	$587,161	$504,317	$1,259,001
Present Worth of Total Costs	**$727,093**	**$1,017,414**	**$973,889**	**$1,749,945**

Table 8-2

Detailed Evaluation of Alternatives Summary

Alternative	Compliance with SCGs	Protection of Human Health and Environment	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost Effectiveness	Land Use
Alternative 1 – No Action/ Monitored Natural Attenuation	Non-compliant	None; contamination remains in groundwater.	Little or none; some natural attenuation may occur.	No short term impacts.	Not effective; PCE levels expected to remain over SCG more than 30 years after release.	Readily implementable	Low cost but limited effectiveness.	Deed or access restrictions.
Alternative 2– Groundwater Extraction with Ex Situ Treatment by Air Stripping/ Monitored Natural Attenuation	Expected to meet SCGs throughout most of site but some areas of non-compliance likely to persist.	Expected to provide protection of human health and the environment.	Expected to achieve significant reductions in contaminant concentrations and toxicity. May also reduce off-site migration (to north) based on positioning of extraction wells.	Requires coordination with owners/tenants (dry cleaner and Getty Service Station) to minimize disruptions of current operations.	Expected to effectively lower PCE levels within 10 years.	Implementable. Coordination with government agencies and owners/tenants required.	High cost but effective remediation expected.	No land use restrictions required.
Alternative 3– In Situ Treatment/ Monitored Natural Attenuation	Expected to meet SCGs throughout most of site but some areas of non-compliance likely to persist.	Expected to provide protection of human health and the environment.	Expected to achieve significant reductions in contaminant concentrations and toxicity.	Requires coordination with owners/tenants (dry cleaner and Getty Service Station) to minimize disruptions of current operations.	Expected to effectively lower PCE levels within 10 years.	Implementable. Coordination with government agencies and owners/tenants required.	High cost but effective remediation expected.	No land use restrictions required.
Alternative 4 – *Treatment at Downgradient Public Wells*/ Monitored Natural Attenuation	Expected to meet SCGs in the public water supply. Non-compliant at site.	Expected to provide protection of human health at downgradient public wells. In the vicinity of the site, none; contamination remains in groundwater.	Contaminant concentrations and toxicity to achieve levels less than NYS Class GA groundwater criteria at the public wells. In the vicinity of the site, little or none; some natural attenuation may occur.	Requires coordination with county to minimize disruptions of current operations.	Expected to effectively lower PCE levels at the downgradient public wells.	Implementable. Coordination with county representatives required.	Moderate cost but effectively mitigates risk from ingestion of public water but no remediation at site.	Deed or access restrictions.



NYSDEC Site No. 152187
Country Cleaners
Huntington, New York

0 500 1,000 2,000
Feet

★ Site

Prepared for:
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Prepared by:
AECOM

Site Location Map

Project No: 60133623
Figure No: 1-1
October 1, 2010

NYSDEC Site No. 152187
Country Cleaners
Huntington, New York

0 17.5 35 70 Feet

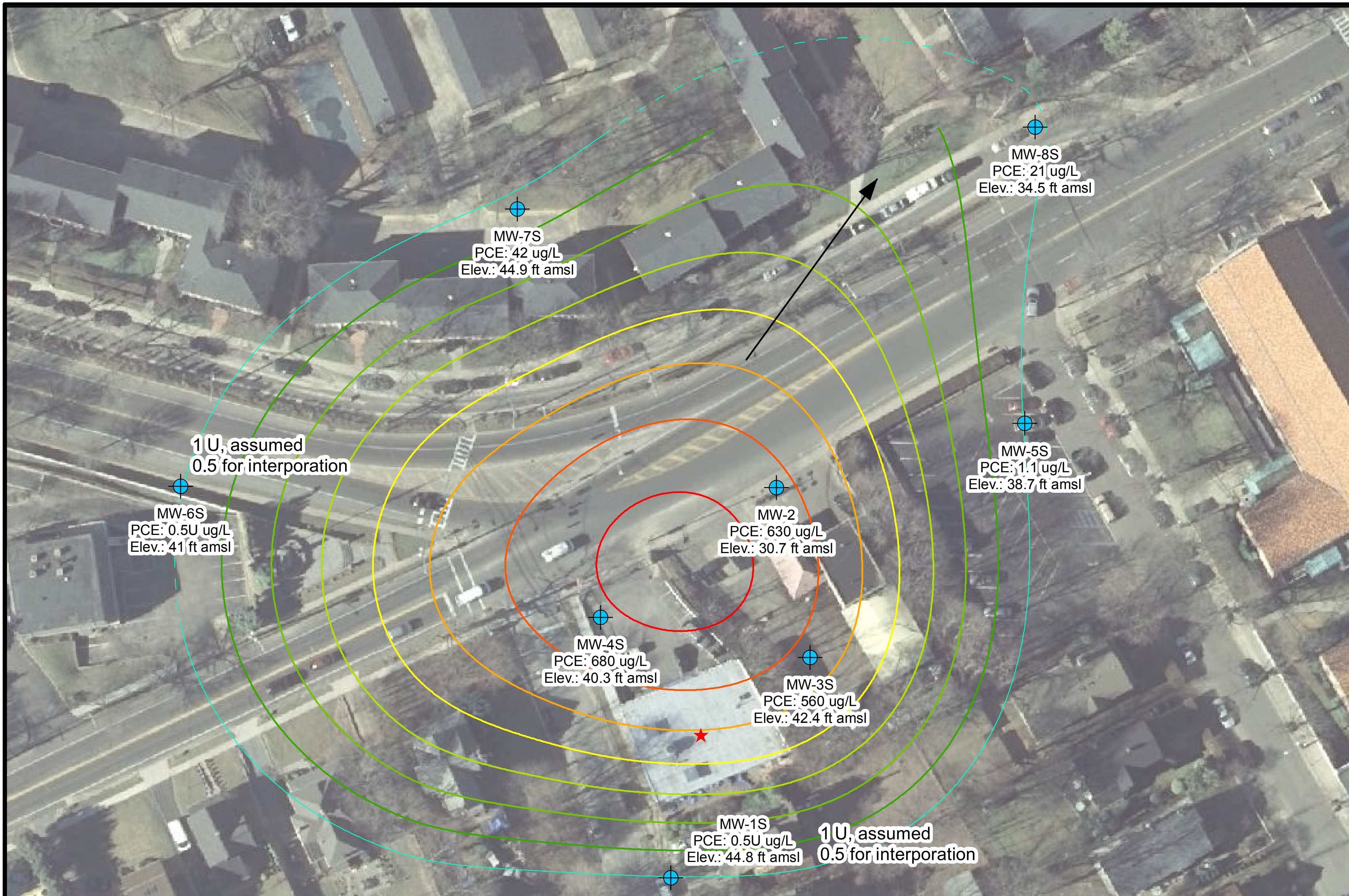
Permanent Monitoring Well
★ Site

Prepared for:
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Prepared by:
AECOM

Site Features

Project No: 60133623
Figure No: 1-2
October 1, 2010



NYSDEC Site No. 152187
Country Cleaners
Huntington, New York

0 17.5 35 70 Feet

PCE Concentration Contour (ug/L)

- 100
- 200
- 300
- 400
- 500
- 600
- 700
- PCE NYS Class GA Groundwater Criterion 5 ug/L
- Extrapolation of 5 ug/L
- Shallow Wells
- Site
- Approximate Groundwater Flow Direction

Labels show the assumed lowest elevation of the PCE plume (ft amsl).

Prepared for: New York State Department of Environmental Conservation

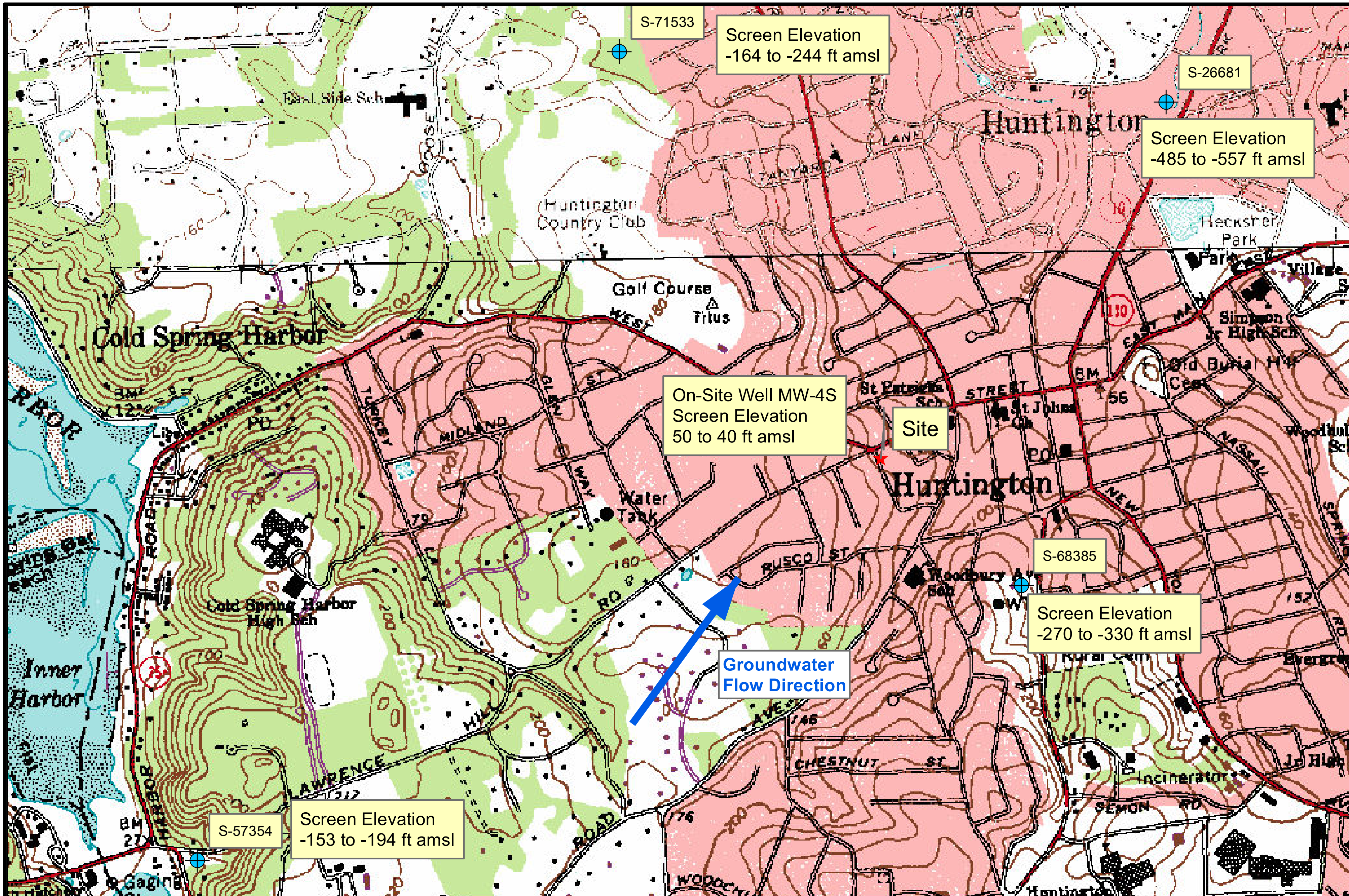
Prepared by: AECOM

PCE Concentration Contours - Shallow Wells

Project No: 60133623

Figure No: 4-1

July 29, 2010



NYSDEC Site No. 152187
Country Cleaners
Huntington, New York

0 500 1,000 2,000 Feet

★ Site
⊕ Suffolk County Water Authority Potable Wells

Prepared for:
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Prepared by:
AECOM

Suffolk County Water Authority
Potable Well Locations

Project No: 60133623
Figure No: 6-1
July 29, 2010

NYSDEC Site No. 152187
Country Cleaners
Huntington, New York

0 7.5 15 30 Feet

Treatment System — Pipes
Extraction Wells ★ Site
Injection Wells

Design assumes the Town of Huntington will permit a connection to the nearest stormwater catch basin. Approval is required during pre-design.

Prepared for: New York State Department of Environmental Conservation

Prepared by: AECOM

Alternative 3 - Conceptual Layout

Project No: 60133623

Figure No: 7-1

October 1, 2010

NYSDEC Site No. 152187
Country Cleaners
Huntington, New York

Prepared for: New York State Department of Environmental Conservation

Prepared by: AECOM

Alternative 4 - Conceptual Layout

Project No: 60133623

Figure No: 7-2

October 1, 2010

Appendix A
Cost Estimates

1. Component SUMMARY OF COSTS	APPENDIX A: COST ESTIMATE				2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY			
5. Program Element ALTERNATIVE 1 - NO ACTION WITH MONITORED NATURAL ATTENUATION	6. Category Code	7. Project Number 60133623		8. Project Cost ($000) $727	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
Total Construction Cost				$45
Contingencies (20%)				$2
Engineering (0%)				$0
Project Management (8%)				$4
Construction Management (0%)				$0
Total Capital Cost				**$51**
Present Worth Capital Costs				**$54**
Annual O&M Costs				
Total Annual O&M Cost				$53
Contingency (5%)				$3
Project Management (8%)				$4
Total Annual O&M Cost				**$60**
Present Worth of O&M Costs (30 year life)				**$673**
Present Worth of Total Costs				**$727**
Guidance Cost Analysis				

10. Description of Proposed Construction:

Notes:

1. The escalation factor for construction costs is 4.2% from ENR (November 2010).
2. The discount factor from Circular-94 Dec 2009 ranged from 0.9% (3-year) to 2.7% (30+years).
4. The construction period is assumed to occur in 2012

1. Component CAPITAL COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 1 - NO ACTION WITH MONITORED NATURAL ATTENUATION	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $727	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
Deed Restriction - Environmental Easement	LS	1	25,000	$25
Site Management Plans	LS	1	20,000	$20
Total Construction Cost				$45
Contingency (5%)				$2
Engineering (0%)				$0
Project Management (8%)				$4
Construction Management (0%)				$0
2010 Construction Costs				**$51**
2012 Construction Costs (4.2% Escalation)				**$55**
Present Worth Construction Costs (0.9% discount)				**$54**

1. Component O&M COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 1 - NO ACTION WITH MONITORED NATURAL ATTENUATION	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $727	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
Groundwater Sampling Event	LS	1	28,443	$28
Events -				
2012-2017				
2022				
2027				
2032				
2037				
2042				
Periodic Review Reports	EA	1	25,000	$25
Total Annual Cost				$53
Contingency (5%)				$3
Project Management (8%)				$4
Total Annual O&M Cost				$60
Future O&M Costs (2012 to 2042)				**$1,049**
Present Worth of O&M Costs (0.9 to 2.7% Discounts)				**$673**

1. Component SUMMARY OF COSTS	APPENDIX A: COST ESTIMATE				2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY			
5. Program Element ALTERNATIVE 2 - EX SITU TREATMENT/MONITORED NATURAL ATTENUATION	6. Category Code	7. Project Number 60133623		8. Project Cost ($000) $1,017	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
Total Construction Cost				$264
Contingencies (20%)				$53
Engineering (15%)				$40
Project Management (8%)				$21
Construction Management (10%)				$26
Total Capital Cost				**$403**
Present Worth Capital Costs				**$430**
Annual O&M Costs				
Total Annual O&M Cost				$122
Contingency (5%-20%)				$6
Project Management (8%)				$10
Total Annual O&M Cost				**$138**
Present Worth of O&M Costs (30 year life)				**$587**
Present Worth of Total Costs				**$1,017**
Guidance Cost Analysis				

10. Description of Proposed Construction:
Notes:
1. The escalation factor for construction costs is 4.2% from ENR (November 2010).
2. The discount factor from Circular-94 Dec 2009 ranged from 0.9% (3-year) to 2.7% (30+years).
4. The construction period is assumed to occur in 2012

1. Component CAPITAL COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 2 - EX SITU TREATMENT/MONITORED NATURAL ATTENUATION	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $1,017	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
Pre-Design Study, Well Installation - 2 Extractions Wells, 1 Injection Well	LS	1	82,142	$82
Electrical and Plumbing, connection to stormwater basin	LS	1	72,160	$72
Treatment Equipment and Installation	LS	1	89,380	$89
Site Management Plans	LS	1	20,000	$20
Total Construction Cost				$264
Contingency (20%)				$53
Engineering (15%)				$40
Project Management (8%)				$21
Construction Management (10%)				$26
2010 Construction Costs				**$403**
2012 Construction Costs (4.2% Escalation)				**$438**
Present Worth Construction Costs (0.9% discount)				**$430**

1. Component O&M COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 2 - EX SITU TREATMENT/MONITORED NATURAL ATTENUATION	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $1,017	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
Assume one year of operation				
Energy	kW	113880	0.14	$16
Site Visits	LS	20	2640	$53
Groundwater Sampling Event	LS	1	28,443	$28
Events -				
2012-2017, 2022, 2032, 2042				
Periodic Review Reports	EA	1	25,000	$25
Total Annual Cost				$122
Contingency (5%)				$6
Project Management (8%)				$10
Total Annual O&M Cost				$138
Future O&M Costs (2012 to 2042)				**$828**
Present Worth of O&M Costs (0.9 to 2.7% Discounts)				**$587**

1. Component SUMMARY OF COSTS	APPENDIX A: COST ESTIMATE				2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY			
5. Program Element ALTERNATIVE 3 - IN SITU TREATMENT	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $974		

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
Total Construction Cost				$288
Contingencies (20%)				$58
Engineering (15%)				$43
Project Management (8%)				$23
Construction Management (10%)				$29
Total Capital Cost				**$440**
Present Worth Capital Costs				**$470**
Annual O&M Costs				
Total Annual O&M Cost				$53
Contingency (5%-20%)				$3
Project Management (8%)				$4
Total Annual O&M Cost				**$60**
Present Worth of O&M Costs (30 year life)				**$504**
Present Worth of Total Costs				**$974**
Guidance Cost Analysis				

10. Description of Proposed Construction:

Notes:

1. The escalation factor for construction costs is 4.2% from ENR (November 2010).
2. The discount factor from Circular-94 Dec 2009 ranged from 0.9% (3-year) to 2.7% (30+years).
4. The construction period is assumed to occur in 2012.

1. Component CAPITAL COSTS	APPENDIX A: COST ESTIMATE				2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY			
5. Program Element ALTERNATIVE 3 - IN SITU TREATMENT	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $974		

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
Pilot Study, Data Evaluation and Reporting	LS	1	20,000	$20
Drilling	LS	1	144,220	$144
Chemicals	LS	1	103,558	$104
Site Management Plans	LS	1	20,000	$20
Total Construction Cost				$288
Contingencies (20%)				$58
Engineering (15%)				$43
Project Management (8%)				$23
Construction Management (10%)				$29
2010 Construction Costs				**$440**
2012 Construction Costs (4.2% Escalation)				**$478**
Present Worth Construction Costs (0.9% discount)				**$470**

1. Component O&M COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 3 - IN SITU TREATMENT	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $974	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
Groundwater Sampling Event	LS	1	28,443	$28
Events -				
2012-2017, 2022, 2032, 2042				
Periodic Review Reports	EA	1	25,000	$25
Total Annual Cost				$53
Contingency (5%)				$3
Project Management (8%)				$4
Total Annual O&M Cost				$60
Future O&M Costs (2012 to 2042)				**$744**
Present Worth of O&M Costs (0.9 to 2.7% Discounts)				**$504**

1. Component SUMMARY OF COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 4 - GROUNDWATER TREATMENT AT DOWNSTREAM PUBLIC WELLS/MNA	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $1,750	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
Total Construction Cost				$301
Contingencies (20%)				$60
Engineering (15%)				$45
Project Management (8%)				$24
Construction Management (10%)				$30
Total Capital Cost				**$460**
Present Worth Capital Costs				**$491**
Annual O&M Costs				
Total Annual O&M Cost				$70
Contingency (5%-20%)				$3
Project Management (8%)				$6
Total Annual O&M Cost				**$79**
Present Worth of O&M Costs (30 year life)				**$1,259**
Present Worth of Total Costs				**$1,750**
Guidance Cost Analysis				

10. Description of Proposed Construction:

Notes:

1. The escalation factor for construction costs is 4.2% from ENR (Oct 2010).
2. The discount factor from Circular-94 Dec 2009 ranged from 0.9% (3-year) to 2.7% (30+years).
4. The construction period is assumed to occur in 2012

1. Component CAPITAL COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 4 - GROUNDWATER TREATMENT AT DOWNSTREAM PUBLIC WELLS/MNA	6. Category Code	7. Project Number 60133623	8. Project Cost ($000) $1,750	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
Treatment System Equipment, Installation and Startup - 650 gpm Supply Well	LS	1	122,268	$122
Treatment System Equipment, Installation and Startup - 1500 gpm Supply Well	LS	1	133,608	$134
Deed Restriction - Environmental Easement	LS	1	25,000	$25
Site Management Plans	LS	1	20,000	$20
Total Construction Cost				$301
Contingencies (20%)				$60
Engineering (15%)				$45
Project Management (8%)				$24
Construction Management (10%)				$30
2010 Construction Costs				**$460**
2012 Construction Costs (4.2% Escalation)				**$500**
Present Worth Construction Costs (0.9% discount)				**$491**

1. Component O&M COSTS	APPENDIX A: COST ESTIMATE			2. Date OCT 2010
3. Site COUNTRY CLEANERS, HUNTINGTON, NY SITE NO. 152187		4. Project Title COUNTRY CLEANERS FEASIBILITY STUDY		
5. Program Element ALTERNATIVE 4 - GROUNDWATER TREATMENT AT DOWNSTREAM PUBLIC WELLS/MNA	6. Category Code	7. Project Number 60133623		8. Project Cost ($000) $1,750

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
Energy	kW-hr	109500	0.14	$15
Annual Maintenance	LS	1	1,000	$1
Groundwater Sampling Event	LS	1	28,443	$28
Events -				
2012-2017, 2022, 2032, 2042				
Periodic Review Reports	EA	1	25,000	$25
Total Annual Cost				$70
Contingency (5%)				$3
Project Management (8%)				$6
Total Annual O&M Cost				$79
Future O&M Costs (2012 to 2042)				**$1,975**
Present Worth of O&M Costs (0.9 to 2.7% Discounts)				**$1,259**

Appendix B
Supporting Calculations

Air Stripper Calculations

Table of Contents

1 TECHNOLOGY DESCRIPTION

As the process name implies, volatile contaminants are "stripped" from the pumped groundwater and into the air. The two most commonly used air stripper systems are packed column and low profile. In a packed tower air stripping system, contaminated water flow down through a column that is filled with randomly packed or structured packing material while air is introduced below the packed bed and flows upward through the column countercurrent to the flow of water. In a low profile aeration system, contaminated water flows down over baffled aeration trays while air is forced upward through the perforations in the trays.

Air stripping is used to separate VOCs from water and is ineffective for inorganic contaminants. Henry's law constant is used to determine whether air stripping will be effective. Generally, organic compounds with constants greater than 0.01 atmospheres - m^3/mol are considered amenable to stripping. Some compounds that have been successfully separated from water using air stripping include BTEX, chloroethane, TCE, DCE, and PCE.

2 INPUTS AND ASSUMPTIONS

In order to model an air stripper and get a preliminary estimate of the size requirements several inputs must be determined. The main inputs listed in Table D-1 are the minimum and maximum volume of water to be air stripped, the minimum temperature of water, the maximum concentration of VOCs in the untreated water, the desired concentrations in the treated water and Henry's constant for the VOCs. In addition, the operation schedule, range of air temperatures, and mineral content, must be considered. It is assumed to run full time for the entire year. The influent air conditions and mineral content are listed in Table D-1.

Table D-1 – Site Information

System	Country On-site 1	Country On-site 2	Country On-site 3	Country Supply Well 1	Country Supply Well 2
Water Influent					
Max PCE (ug/L)	700	700	700	10	10
Min Liquid Temp (deg.F)	60	60	60	60	60
Flow Rate (gpm)	200	1,000	2,000	650	1500
Water Effluent					
PCE (ug/L) less than	5	5	5	5	5
Air Influent					
PCE less than	0	0	0	0	0
Water Quality					
Iron (unfiltered) ug/L	340-500	340-500	340-500		
Iron (filtered) ug/L	<150	<150	<150	<100	<100
Manganese (unfiltered) ug/L	<25 to 28	<25 to 28	<25 to 28		
Manganese (filtered) ug/L	<25	<25	<25	<1	<1
Calcium ug/L				7,000-10,000	7,000-10,000
Magnesium ug/L				3,000-4,000	3,000-4,000

2.1 Air Flow Rates

The air flow rate for a given VOC concentration is generally lower for a packed column air stripper than a low profile air stripper. The range of air flow rates for the two types of air strippers is 5 to 250 cfm/ft^2 for a packed column and 30 to 60 cfm/ft^2 (US Army Corps of

Engineers [USACE], 2001). Thus the tray area for a low profile air stripper will be greater than the tower cross sectional area for the same conditions. For both types of air strippers if the air flow rate is too high flooding may occur, in which case the water floods the top of the air stripper. There is a narrow range of possible air flow rates for the low profile air stripper since a rate that is too high will force the air through the holes in the trays too quickly forming a jet and dispersing the water and if the air flow rate is too low the water will drip through the holes in the trays. Both of these conditions negatively affect the efficiency of the stripper.

2.2 Water Flow Rates

Based on the hydraulic conductivity of the area and the desired capture water flow rates ranging from 200 to 2,000 gpm were examined. The range of water flow rates for the two types of air strippers is 20 to 45 gpm/ft^2 for a packed column and 1 to 15 cfm/ft^2 (USACE, 2001).

2.3 Other Inputs

All the values used in the calculations are provided in the attached calculations sheets.

3 RESULTS

For the packed column analysis, the on-site well packing depths ranged from 19 to 38 ft with diameters ranging from 3 to 10 ft. The supply well packed column packing depths ranged from 3 to 5 ft with diameters ranging from 5 to 9 ft. The on-site wells would require low profile systems with 4 to 5 trays with areas ranging from 7 to 220 ft^2. The supply wells would require low profile systems with at least one tray with areas ranging from 22 to 165 ft^2.

For the emissions analysis, for an added measure of conservatism, the air stripper is assumed to be 100% efficient, and therefore, all of the VOCs are emitted into the air. This analysis uses worst-case values. Actual air emissions will be less than in this conservative analysis. The on-site wells were estimated to emit between 0.3 and 3 tons per year.

4 FURTHER CONSIDERATIONS

Air strippers may become fouled by mineral deposits. In cases of high metal concentrations pre-treatmend of the water prior to stripping may be necessary. In general fouling is a concern when the calcium levels are greater than 40 mg/L, iron is greater than 0.3 mg/L, magnesium is greater than 10 mg/L or manganese is greater than 0.05 mg/L. Fouling may also occur if there is excessive biological growth. After fouling has occurred and compromised the effectiveness of the air stripper, maintenance is required. For packed column air strippers the packing must eigher be removed for cleaning or washed with an acid solution. Since these operations are both costly, low profile air strippers are often desirable when fouling is expected (USACE, 2001). Low profiles generally are easier to clean after fouling.

The following factors may limit the applicability and effectiveness of the process:

- The potential exists for inorganic (e.g., iron greater than 5 ppm, hardness greater than 800 ppm) or biological fouling of the equipment, requiring pretreatment or periodic column cleaning.
- Off-gases may require treatment based on mass emission rate.

5 REFERENCES

US Army Corps of Engineers, 2001. Engineer Design Guide, DG 1110-1-3, Engineering and Design-Air Stripping, October 31, 2001.

System	Country On-site 1	Country On-site 2	Country On-site 3	Country Supply Well 1	Country Supply Well 2
Water Influent					
Max PCE (ug/L)	700	700	700	10	10
Min Liquid Temp (deg.F)	60	60	60	60	60
Flow Rate (gpm)	200	1,000	2,000	650	1500
Water Effluent					
PCE (ug/L) less than	5	5	5	5	5
Air Influent					
PCE less than	0	0	0	0	0
Water Quality					
Iron (unfiltered) ug/L	340-500	340-500	340-500		
Iron (filtered) ug/L	<150	<150	<150	<100	<100
Manganese (unfiltered) ug/L	<25 to 28	<25 to 28	<25 to 28		
Manganese (filtered) ug/L	<25	<25	<25	<1	<1
Calcium ug/L				7,000-10,000	7,000-10,000
Magnesium ug/L				3,000-4,000	3,000-4,000
Air Emissions (tons/year)	0.307	1.535	3.070	0.014	0.033

PCE Henry's Constant H (atm) @ 60F =	800
PCE Henry's Constant H (unitless) @ 60F =	0.6

		Packed Column	Low Profile
min air flow rate	cfm/ft^2	5	30
max air flow rate	cfm/ft^2	250	60
min water flow rate	gpm/ft^2	20	1
max water flow rate	gpm/ft^2	45	15
Min A/W ratio	cfm/gpm	0.11	2.00
Max A/W ratio	cfm/gpm	12.50	7.50

PACKED COLUMN EQUATIONS (page 1 of 2)
From USACE, 2001.

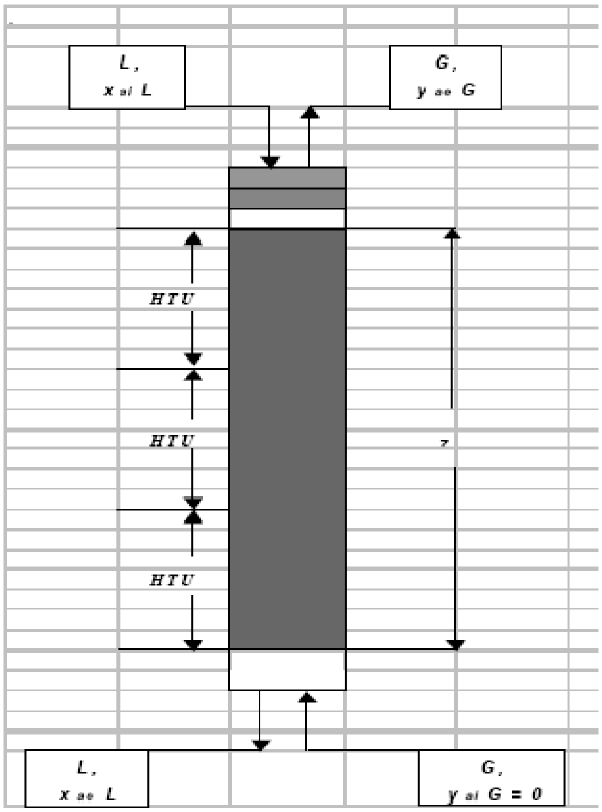


Figure D-1. Random "dumped" packed tower.

Table D-5
Water at 20°C (293.16 K)

$s = 0.072764 \frac{N}{m} = \frac{kg}{s^2}$	liquid surfacetension
$\mu_L = 0.0010042 \frac{kg}{m\,s}$	liquidviscosity
$\rho_L = 998.20 \frac{kg}{m^3}$	liquid density

Table D-7
Air at 20°C (293.16 K) and 1 atm

$\mu_G = 1.773 \times 10^{-5} \frac{kg}{m\,s}$	gasviscosity
$\rho_G = 1.2046 \frac{kg}{m^3}$	gasdensity

Table D-6
Packing Characteristics

$d_p = 0.0508$ m	nominal diameter
$a_t = 157 \frac{m^2}{m^3}$	totalsurfacearea
$s_c = 0.033 \frac{kg}{s^2}$	criticalsurfacetension for polyethylenepacking
$c_f = 15$	packing factor

PACKED COLUMN EQUATIONS (page 2 of 2)

From USACE, 2001.

Assuming influent air has not PCE:

$$\frac{Q_{G\ min}}{Q_L} = \frac{(C_{ai} - C_{ae})}{H_a C_{ai}}$$

$$L = \rho_L \frac{Q_L}{A} \left[\frac{kg}{m^2\ s}\right]$$

$$N_{Re} = \frac{V_L \rho_L}{a_t\ \mu_L} \quad \text{(Reynolds Number)}$$

$$N_{Fr} = \frac{a_t V_L^2}{g_c} \quad \text{(FroudeNumber)}$$

$$N_{We} = \left(\frac{1}{a_t}\right) \frac{V_L^2 \rho_L}{g_c s} \quad \text{(Weber Number)}$$

Calculate the wetted area of the packing, a_w from the dimensionless relation:

$$\frac{a_w}{a_t} = 1 - \exp\left[-1.45\left(\frac{s_c}{s}\right)^{0.75}\left(N_{Re}^{\ 0.1} N_{Fr}^{\ -0.05} N_{We}^{\ 0.2}\right)\right]$$

k. Calculate the liquid phase mass transfer coefficient, Onda K_L from the following relationship:

$$K_L\left(\frac{\rho_L}{\mu_L g_c}\right)^{\frac{1}{3}} = 0.0051\left(\frac{V_L\ \rho_L}{a_w\ \mu_L}\right)^{\frac{2}{3}}\left(\frac{\mu_L}{\rho_L D_L}\right)^{-0.5}\left(a_t d_p\right)^{0.4}$$

l. Calculate the gas phase mass transfer coefficient, Onda K_G, using a stripping factor (R) between 2 and 5. Try $R = 2.5$ if air pollution control is required, $R = 4.5$ if it isn't.

$$\frac{K_G}{(a_t D_G)} = 5.23\left(\frac{G}{a_t\ \mu_G}\right)^{0.7}\left(\frac{\mu_G}{\rho_G D_G}\right)^{\frac{1}{3}}\left(a_t d_p\right)^{-2.0}$$

q. Calculate the overall mass transfer coefficient, Onda K_{LA}.

$$\frac{1}{K_{LA}} = \frac{1}{H'_a\ K_G\ a_w} + \frac{1}{K_L\ a_w}$$

$$HTU = \frac{V_L}{K_{LA}}$$

$$NTU = \left(\frac{R}{R-1}\right) \ln\left(\frac{\left[\left(\frac{x_{ai}}{x_{ae}}\right)(R-1)\right]+1}{R}\right)$$

$$Z = NTU \times HTU \text{ packingdepth[m]}$$

LOW PROFILE EQUATIONS (page 1 of)

From USACE, 2001.

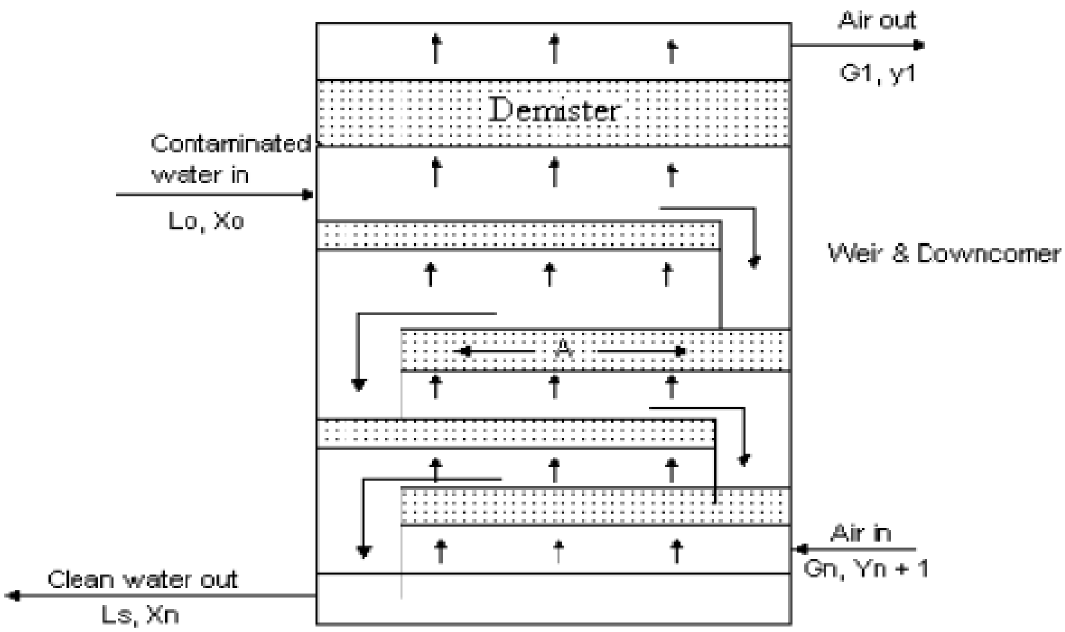


Figure C-1. Cross-sectional area of perforated plate section.

$$N_{\text{theoretical}} = \frac{\log\left[\frac{\left(X_0 - \frac{Y_{n+1}}{m}\right)}{\left(X_n - \frac{Y_{n+1}}{m}\right)}\left(1 - \frac{1}{S}\right) + \frac{1}{S}\right]}{\log S}$$

where

X_0	=	concentration of contaminant (TCE) in the inlet water phase: 10 mg/L
X_n	=	concentration of contaminant (TCE) in the treated water phase: 0.1 mg/L
N	=	number of theoretical plates. Assumes that the liquid on each plate is completely mixed and that the vapor leaving the plates is in equilibrium with the liquid.
H	=	Henry's Constant (atm)
m	=	slope of equilibrium curve (H/Pt)
G	=	lb-moles air/min
L	=	lb-moles of water/min
S	=	stripping factor (mG/L)
Pt	=	ambient pressure (atm)
Y_{n+1}	=	concentration of volatiles in the air entering the air stripper.

		Reference Values	Country 1-lower	Country 1-upper	Country 2-lower	Country 2-upper	Country 3-lower	Country 3-upper	Country SW1-lower
Preliminary Stripper Cross Section									
water flow rate per cross section	gpm/ft^2		26	45	26	45	26	45	26
Water flow rate	gpm		200	200	1,000	1,000	2,000	2,000	650
total cross section	ft2		7.7	4.4	38.5	22.2	76.9	44.4	25.0
Number of Strippers			1	1	1	1	1	1	1
prelim cross section per stripper	ft2		7.7	4.4	38.5	22.2	76.9	44.4	25.0
prelim diameter of strippers	ft		3.13	2.38	7.00	5.32	9.90	7.52	5.64
Standard Diameter Stripper									
diameter (d)	**ft**		**4**	**3**	**7**	**6**	**10**	**8**	**6**
packing material diameter	in		4	3	7	6	10	8	6
water flow rate per stripper (QL)	gpm		200	200	1000	1000	2000	2000	650
cross section per stripper (A)	ft2		12.6	7.1	38.5	28.3	78.5	50.3	28.3
water flow rate per cross section (VL)	gpm/ft2	20-45	15.9	28.3	26.0	35.4	25.5	39.8	23.0
water flow rate per stripper (QL)	m3/s		0.0126	0.0126	0.0631	0.0631	0.1262	0.1262	0.0410
diameter (d)	m3/s		1.22	0.91	2.13	1.83	3.05	2.44	1.83
cross section per stripper (A)	m2		1.17	0.66	3.58	2.63	7.30	4.67	2.63
water flow rate per cross section (VL)	m/s		0.0108	0.0192	0.0176	0.0240	0.0173	0.0270	0.0156
Untreated Water Conc. (Cai)	ug/L		700	700	700	700	700	700	10
Treated Water Conc. (Cae)	ug/L		5	5	5	5	5	5	5
Henry's Constant (H')	unitless	0.6							
A/W ratio minimum (Qgmin/QL)	m3/m3		1.65	1.65	1.65	1.65	1.65	1.65	0.83
gravitational constant (gc)	m/s2	9.807							
liquid surfacetension of water at 60 F (s)	kg/s2	0.072764							
liquid viscosity of water at 60 F (μ_L)	kg/ms	0.0010042							
liquid density of water at 60 F (ρ_L)	kg/m3	998.2							
Liquid Diffusivity of PCE at 60 F (DL)	m2/s	5.86E-10							
nominal diameter (d_p)	m	0.0508							
total surface area (a_t)	m2/m3	157							
critical surface tension for polyethylene packing (s_c)	kg/s2	0.033							
packing factor (c_f)	unitless	15							
Liquid mass velocity	kg/m2s		10.8	19.2	17.6	24.0	17.3	27.0	15.6
Reynolds Number (Nre)			68.4	121.7	111.7	152.1	109.5	171.1	98.8
Nre^0.1			1.53	1.62	1.60	1.65	1.60	1.67	1.58

		Reference Values	Country 1-lower	Country 1-upper	Country 2-lower	Country 2-upper	Country 3-lower	Country 3-upper	Country SW1-lower
Froude Number (NFr)			0.00187	0.00591	0.00498	0.00924	0.00479	0.01169	0.00390
NFr^-0.05			1.37	1.29	1.30	1.26	1.31	1.25	1.32
Weber Number (Nwe)			0.00104	0.00329	0.00277	0.00514	0.00266	0.00651	0.00217
Nwe^0.2			0.253	0.319	0.308	0.348	0.306	0.365	0.293
wetted area (aw)	m2/m3		54.2	64.9	63.3	69.4	62.9	71.8	60.9
Liquid phase mass transfer coefficient (KL)	m/s		0.00021	0.00027	0.00026	0.00030	0.00026	0.00031	0.00024
gasviscosity of air at 60 F (μ_G)	kg/ms	1.77E-05							
gas density of air at 60 F (ρ_G)	kg/m3	1.2046							
Gas Diffusivity of PCE at 60 F (Dg)	m2/s	7.13E-06							
Gas flow rate (VGmin=QGmin/QL*VL)	m/s		0.018	0.032	0.029	0.040	0.029	0.045	0.013
Stripping Factor (R)	unitless	2.5 to 4.5 or 10	15	2.5	15	2.5	15	2.5	15
Gas flow rate (VG=Vgmin*R)	m/s		0.268	0.079	0.438	0.099	0.429	0.112	0.195
Gas flow rate (QG)	m3/s		0.313	0.052	1.566	0.261	3.132	0.522	0.513
Gas flow rate (G=VG*ρG)	kg/sm2		0.323	0.096	0.528	0.120	0.517	0.135	0.235
Gas phase mass transfer coefficient (KG)	m/s		3.27E-03	1.39E-03	4.61E-03	1.63E-03	4.54E-03	1.77E-03	2.62E-03
Overall Mass Transfer Coefficient (KLA)	s^-1		0.010	0.013	0.015	0.016	0.015	0.017	0.013
Height of transfer unit (HTU)	m		1.1	1.5	1.2	1.5	1.2	1.6	1.2
Number of Transfer Units (NTU)	unitless		5.2	7.4	5.2	7.4	5.2	7.4	0.7
Packing depth (Z)	m		5.6	10.8	6.2	11.2	6.2	11.5	0.9
Packing depth (Z)	**ft**		**18.3**	**35.4**	**20.3**	**36.8**	**20.2**	**37.6**	**2.8**
Air to Water Ratio (A/W)	m3 air/m3 H2O		24.8	4.1	24.8	4.1	24.8	4.1	12.5
Air to Water Ratio (A/W)	cfm/gpm		3.3183305	0.5530551	3.3183305	0.5530551	3.3183305	0.5530551	1.671101673
Air to Water Ratio (A/W)	cfm/cfm		24.821112	4.136852	24.821112	4.136852	24.821112	4.136852	12.49984051
Air flow rate	cfm		663.66609	110.61102	3318.3305	553.05508	6636.6609	1106.1102	1086.216087
Air flow rate (cfm/ft2 packed column)			52.81287	15.648258	86.225093	19.560322	84.500591	22.005362	38.41703545
Water flow rate (gpm/ft2 packed column)			15.915494	28.294212	25.984481	35.367765	25.464791	39.788736	22.98904734

		Country SW1-upper	Country SW2-lower	Country SW2-upper
Preliminary Stripper Cross Section				
water flow rate per cross section	gpm/ft^2	45	26	45
Water flow rate	gpm	650	1,500	1,500
total cross section	ft2	14.4	57.7	33.3
Number of Strippers		1	1	1
prelim cross section per stripper	ft2	14.4	57.7	33.3
prelim diameter of strippers	ft	4.29	8.57	6.51
Standard Diameter Stripper				
diameter (d)	**ft**	**5**	**9**	**7**
packing material diameter	in	5	9	7
water flow rate per stripper (QL)	gpm	650	1500	1500
cross section per stripper (A)	ft2	19.6	63.6	38.5
water flow rate per cross section (VL)	gpm/ft2	33.1	23.6	39.0
water flow rate per stripper (QL)	m3/s	0.0410	0.0946	0.0946
diameter (d)	m3/s	1.52	2.74	2.13
cross section per stripper (A)	m2	1.82	5.91	3.58
water flow rate per cross section (VL)	m/s	0.0225	0.0160	0.0265
Untreated Water Conc. (Cai)	ug/L	10	10	10
Treated Water Conc. (Cae)	ug/L	5	5	5
Henry's Constant (H')	unitless			
A/W ratio minimum (Qgmin/QL)	m3/m3	0.83	0.83	0.83
gravitational constant (gc)	m/s2			
liquid surfacetension of water at 60 F (s)	kg/s2			
liquid viscosity of water at 60 F (μ_L)	kg/ms			
liquid density of water at 60 F (ρ_L)	kg/m3			
Liquid Diffusivity of PCE at 60 F (DL)	m2/s			
nominal diameter (d_p)	m			
total surface area (a_t)	m2/m3			
critical surface tension for polyethylene packing (s_c)	kg/s2			
packing factor (c_f)	unitless			
Liquid mass velocity	kg/m2s	22.4	16.0	26.4
Reynolds Number (Nre)		142.3	101.4	167.6
Nre^0.1		1.64	1.59	1.67

		Country SW1-upper	Country SW2-lower	Country SW2-upper
Froude Number (NFr)		0.00809	0.00410	0.01122
NFr^-0.05		1.27	1.32	1.25
Weber Number (Nwe)		0.00450	0.00228	0.00624
Nwe^0.2		0.339	0.296	0.362
wetted area (aw)	m2/m3	68.0	61.4	71.4
Liquid phase mass transfer coefficient (KL)	m/s	0.00029	0.00025	0.00031
gasviscosity of air at 60 F (μ_G)	kg/ms			
gas density of air at 60 F (ρ_G)	kg/m3			
Gas Diffusivity of PCE at 60 F (Dg)	m2/s			
Gas flow rate (VGmin=QGmin/QL*VL)	m/s	0.019	0.013	0.022
Stripping Factor (R)	unitless	2.5	15	2.5
Gas flow rate (VG=Vgmin*R)	m/s	0.047	0.200	0.055
Gas flow rate (QG)	m3/s	0.085	1.183	0.197
Gas flow rate (G=VG*ρG)	kg/sm2	0.056	0.241	0.066
Gas phase mass transfer coefficient (KG)	m/s	9.63E-04	2.66E-03	1.08E-03
Overall Mass Transfer Coefficient (KLA)	s^-1	0.013	0.013	0.015
Height of transfer unit (HTU)	m	1.7	1.2	1.8
Number of Transfer Units (NTU)	unitless	0.8	0.7	0.8
Packing depth (Z)	m	1.3	0.9	1.4
Packing depth (Z)	**ft**	**4.4**	**2.8**	**4.5**
Air to Water Ratio (A/W)	m3 air/m3 H2O	2.1	12.5	2.1
Air to Water Ratio (A/W)	cfm/gpm	0.278516945	1.671101673	0.278516945
Air to Water Ratio (A/W)	cfm/cfm	2.083306752	12.49984051	2.083306752
Air flow rate	cfm	181.0360145	2506.652509	417.7754181
Air flow rate (cfm/ft2 packed column)		9.220088508	39.40208764	10.85567721
Water flow rate (gpm/ft2 packed column)		33.10422816	23.57851009	38.97672076

Scenario		Country 1-lower	Country 1-upper	Country 2-lower	Country 2-upper	Country 3-lower	Country 3-upper	Country SW1-lower	Country SW1-upper
Untreated Water Conc. (Xo)	ug/L	700	700	700	700	700	700	10	10
Treated Water Conc. (Xn)	ug/L	5	5	5	5	5	5	5	5
Air In conc. (Yn+1)	ug/L	0	0	0	0	0	0	0	0
Henry's Constant (H)	atm	800	800	800	800	800	800	800	800
Ambient Pressur (Pt)	atm	1	1	1	1	1	1	1	1
Slope of Equilibrium curve (m=H/Pt)		800	800	800	800	800	800	800	800
Water Flowrate (L)	gpm	200	200	1,000	1,000	2,000	2,000	650	650
Conversion to lb-mol/min		0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
L	lb-mol/min	92.68	92.68	463.39	463.39	926.78	926.78	301.20	301.20
A/W Ratio	cfm/gpm	2.00	3.30	2.00	3.30	2.00	3.30	2.00	3.30
Air Flowrate (G)	cfm	400	660	2,000	3,300	4,000	6,600	1,300	2,145
Conversion to lb-mol/min		0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
G	lb-mol/min	1.05	1.74	5.26	8.68	10.53	17.37	3.42	5.64
Stripping Factor (S)		9.09	14.99	9.09	14.99	9.09	14.99	9.09	14.99

N(theoretical)		2.19	1.80	2.19	1.80	2.19	1.80	0.29	0.24
Tray Efficiency E		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
N(actual)		**5**	**4**	**5**	**4**	**5**	**4**	**1**	**1**
Exchange Tray area min	ft2	7	11	33	55	67	110	22	36
Exchange Tray area max	ft2	13	22	67	110	133	220	43	72

Tray Area with weir/downcomer	ft2	8	13.2	40	66	80	132	26	42.9
Tray Area with weir/downcomer	ft2	16	26.4	80	132	160	264	52	85.8

pressure drop per tray (estimated)	in wc	4	4	4	4	4	4	4	4
pressure drop across piping (estimated)	in wc	10	10	10	10	10	10	10	10
Total pressure drop	in wc	30	26	30	26	30	26	14	14

Scenario		Country SW2-lower	Country SW2-upper
Untreated Water Conc. (Xo)	ug/L	10	10
Treated Water Conc. (Xn)	ug/L	5	5
Air In conc. (Yn+1)	ug/L	0	0
Henry's Constant (H)	atm	800	800
Ambient Pressur (Pt)	atm	1	1
Slope of Equilibrium curve (m=H/Pt)		800	800
Water Flowrate (L)	gpm	1,500	1,500
	Conversion to lb-mol/min	0.46	0.46
L	lb-mol/min	695.08	695.08
A/W Ratio	cfm/gpm	2.00	3.30
Air Flowrate (G)	cfm	3,000	4,950
	Conversion to lb-mol/min	0.0026	0.0026
G	lb-mol/min	7.89	13.03
Stripping Factor (S)		9.09	14.99

N(theoretical)		0.29	0.24
Tray Efficiency E		0.5	0.5
N(actual)		**1**	**1**
Exchange Tray area min	ft2	50	83
Exchange Tray area max	ft2	100	165

Tray Area with weir/downcomer	ft2	60	99
Tray Area with weir/downcomer	ft2	120	198

pressure drop per tray (estimated)	in wc	4	4
pressure drop across piping (estimated)	in wc	10	10
Total pressure drop	in wc	14	14

GW TECHNOLOGY:	Ex Situ Air Stripping--Packed Tower			
RACER PARAMETERS	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		Large Site	
Remedial Action:	Easy	Difficult	Easy	Difficult
Media/Waste Type	Groundwater	Groundwater	Groundwater	Groundwater
Contaminant	VOCs	VOCs	VOCs	VOCs
Approach	Ex Situ	Ex Situ	Ex Situ	Ex Situ
System Definition:				
Type of Air Stripper	Packed Tower	Packed Tower	Packed Tower	Packed Tower
Influent Flow Rate (GPM)	50	50	500	500
Volatility of Contaminants	High	Low	High	Low
Removal Percentage	98%	98%	98%	98%
Safety Level	D	D	D	D
Configuration (Packed Tower):				
Number of Towers in Series	1	2	1	2
Packed Tower Diameter (ft)	2	2	6	6
Packed Tower Height (ft)	25	20	25	20
Low Profile Stripper Number of Trays	0	0	0	0
Number of Strippers	1	1	1	1
Configuration (Low profile tray stack):				
Packed Tower Diameter (ft)	N/A	N/A	N/A	N/A
Packed Tower Height (ft)	N/A	N/A	N/A	N/A
Low Profile Stripper Number of Trays	N/A	N/A	N/A	N/A
Number of Strippers	N/A	N/A	N/A	N/A
O&M:				
Assign Startup Costs	Exclude from estimate	Exclude from estimate	Exclude from estimate	Exclude from estimate
Duration (YR)	2	2	5	5
Treatment Train Systems Maintenance Level	Moderate	Moderate	Moderate	Moderate
Sampling Frequency	Monthly	Monthly	Monthly	Monthly
Ex Situ Air Stripping Marked-up Costs	$56,304	$105,433	$124,371	$301,156
Additional Costs:				
O&M	$60,346	$60,346	$388,942	$388,942
Remedial Design (10% or 10K)	$6,756	$11,598	$13,681	$30,116
TOTAL MARKED-UP COSTS	$123,406	$177,377	$526,994	$720,214
GALLONS TREATED	52,560,000	52,560,000	1,314,000,000	1,314,000,000
COST PER GALLON	$0.0023	$0.0034	$0.0004	$0.0005
COST PER 10,000 GALLONS	$23	$34	$4	$5

Stripper Data

Stripper	Select	Max Liquid Flow	Air Flow	4-Tray Height	6-Tray Height	Width	Length	Diameter	Tray Area
Model	**Model**	**(gpm)**	**(cfm)**	**(in)**	**(in)**	**(in)**	**(in)**	**(in)**	**(ft2)**
EZ-Stacker 2.xp	●	25	140	83	103	0	0	27	2
EZ-Stacker 4.xp	○	40	280	83	103	0	0	37	4
EZ-Tray 4.x	○	50	210	82	102	26	29	0	4
EZ-Tray 6.x	○	65	320	82	102	26	37	0	6
EZ-Tray 8.x	○	75	420	82	102	26	49	0	8
EZ-Tray 12.x	○	120	600	82	102	26	73	0	12
EZ-Tray 16.x	○	150	850	84	104	52	49	0	16
EZ-Tray 24.x	○	250	1300	84	104	52	73	0	24
EZ-Tray 36.x	○	375	1900	100	120	100	73	0	36
EZ-Tray 48.x	○	500	2600	110	130	124	73	0	48
EZ-Tray 72.x	○	750	3800	110	130	100	146	0	72
EZ-Tray 96.x	○	1000	5200	110	130	124	146	0	96

QED Air Stripper Model ver. 2.01

11/9/2010

Site Data

Name: Country Cleaners

e-mail: celeste.foster@aecom.com

Project: On-site 1

Units: English

Altitude: 50 ft

Air Temp: 50 F

Flow: 200 gpm

Water Temp: 50 F

Stripper: EZ-Tray 24.x - Click for details

Stripper Air Flow: 1300 cfm

Stripper Max Flow: 250 gpm

Water Results

Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray % Removal	6-Tray Results (ppb)	6-Tray % Removal
tetrachloroethylene (PERC,PCE)	700	5	< 1	100.000	< 1	100.000

Air Results

Contaminant	4-Tray (ppmV)	4-Tray (lb/hr)	6-Tray (ppmV)	6-Tray (lb/hr)
tetrachloroethylene (PERC,PCE)	2.0161	0.07007	2.0169	0.07010

Notes

PH-> 1-800-624-2026 or 1-734-995-2547, FX-> 1-734-995-1170. E-mail->info@qedenv.com. WEB->www.qedenv.com.

The QED modeler estimates unit performance for the listed contaminants. ***Results assume -***

1. *dissolved-phase contaminant within a water matrix*
2. *clean stripper air*
3. *no surfactants, oil, grease or other immiscible phase(s) in the influent*
4. *unit operated within the given parameters and as instructed in the O&M manual*

Stripper performance shall meet or exceed either the required effluent concentration(s) or effluent estimates, whichever is greater, for the conditions supplied and assumes the influent concentrations of each contaminant are less than 25% solubility in water. QED makes no claim of the model's accuracy beyond the 25% solubility in water limit.

Contact Us

Fill out your contact and project information and click Send to have a QED Treatment

application specialist contact you.

Name -	Country Cleaners		
Company -	Company		
Phone -	Phone	**Fax -**	Fax
e-mail -	celeste.foster@aecom.com	**Project -**	On-site 1

Application Notes

Send Reset

Save Data

Use the following URL to reconstruct your data form for future remodeling with changes. This URL can be saved in any text file for record keeping and later retrieval. This run's URL:

```
http://64.9.214.199/cgi-bin/remodel.pl?
u=e&tw=50&ta=50&f=200&a=50&s=24.x&n=Count&e=celeste.foster@aecom.com&
p=On-si&c=182,700;
```

QED Air Stripper Model ver. 2.01	11/9/2010

Site Data

Name: Country Cleaners
e-mail: celeste.foster@aecom.com
Project: On-site 2
Units: English
Altitude: 50 ft
Air Temp: 50 F
Flow: 1000 gpm
Water Temp: 50 F
Stripper: EZ-Tray 96.x - Click for details
Stripper Air Flow: 5200 cfm
Stripper Max Flow: 1000 gpm

Water Results

Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray % Removal	6-Tray Results (ppb)	6-Tray % Removal
tetrachloroethylene (PERC,PCE)	700	5	< 1	100.000	< 1	100.000

Air Results

Contaminant	4-Tray (ppmV)	4-Tray (lb/hr)	6-Tray (ppmV)	6-Tray (lb/hr)
tetrachloroethylene (PERC,PCE)	2.5193	0.35024	2.5212	0.35050

Notes

PH-> 1-800-624-2026 or 1-734-995-2547, FX-> 1-734-995-1170. E-mail->info@qedenv.com. WEB->www.qedenv.com.

The QED modeler estimates unit performance for the listed contaminants. ***Results assume -***

1. *dissolved-phase contaminant within a water matrix*
2. *clean stripper air*
3. *no surfactants, oil, grease or other immiscible phase(s) in the influent*
4. *unit operated within the given parameters and as instructed in the O&M manual*

Stripper performance shall meet or exceed either the required effluent concentration(s) or effluent estimates, whichever is greater, for the conditions supplied and assumes the influent concentrations of each contaminant are less than 25% solubility in water. QED makes no claim of the model's accuracy beyond the 25% solubility in water limit.

Contact Us

Fill out your contact and project information and click Send to have a QED Treatment

application specialist contact you.

Name - Country Cleaners

Company - Company

Phone - Phone **Fax -** Fax

e-mail - celeste.foster@aecom.com **Project -** On-site 2

Application Notes

Send Reset

Save Data

Use the following URL to reconstruct your data form for future remodeling with changes. This URL can be saved in any text file for record keeping and later retrieval. This run's URL:

```
http://64.9.214.199/cgi-bin/remodel.pl?
u=e&tw=50&ta=50&f=1000&a=50&s=96.x&n=Count&e=celeste.foster@aecom.com
&p=On-si&c=182,700;
```

QED Air Stripper Model ver. 2.01	11/9/2010

Site Data

Name: Country Cleaners

e-mail: celeste.foster@aecom.com

Project: Off-site 1

Units: English

Altitude: 50 ft

Air Temp: 50 F

Flow: 650 gpm

Water Temp: 50 F

Stripper: EZ-Tray 72.x - Click for details

Stripper Air Flow: 3800 cfm

Stripper Max Flow: 750 gpm

Water Results

Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray % Removal	6-Tray Results (ppb)	6-Tray % Removal
tetrachloroethylene (PERC,PCE)	10	5	< 1	100.000	< 1	100.000

Air Results

Contaminant	4-Tray (ppmV)	4-Tray (lb/hr)	6-Tray (ppmV)	6-Tray (lb/hr)
tetrachloroethylene (PERC,PCE)	0.0320	0.00325	0.0320	0.00325

Notes

PH-> 1-800-624-2026 or 1-734-995-2547, FX-> 1-734-995-1170. E-mail->info@qedenv.com. WEB->www.qedenv.com.

The QED modeler estimates unit performance for the listed contaminants. ***Results assume -***

1. *dissolved-phase contaminant within a water matrix*
2. *clean stripper air*
3. *no surfactants, oil, grease or other immiscible phase(s) in the influent*
4. *unit operated within the given parameters and as instructed in the O&M manual*

Stripper performance shall meet or exceed either the required effluent concentration(s) or effluent estimates, whichever is greater, for the conditions supplied and assumes the influent concentrations of each contaminant are less than 25% solubility in water. QED makes no claim of the model's accuracy beyond the 25% solubility in water limit.

Contact Us

Fill out your contact and project information and click Send to have a QED Treatment

application specialist contact you.

Name -	Country Cleaners		
Company -	Company		
Phone -	Phone	**Fax -**	Fax
e-mail -	celeste.foster@aecom.com	**Project -**	Off-site 1

Application Notes

Send Reset

Save Data

Use the following URL to reconstruct your data form for future remodeling with changes. This URL can be saved in any text file for record keeping and later retrieval. This run's URL:

```
http://64.9.214.199/cgi-bin/remodel.pl?
u=e&tw=50&ta=50&f=650&a=50&s=72.x&n=Count&e=celeste.foster@aecom.com&
p=Off-s&c=182,10;
```

QED Air Stripper Model ver. 2.01	11/9/2010

Site Data

Name: Crystal

e-mail: celeste.foster@aecom.com

Project: On 1

Units: English

Altitude: 50 ft

Air Temp: 50 F

Flow: 500 gpm

Water Temp: 50 F

Stripper: EZ-Tray 48.x - Click for details

Stripper Air Flow: 2600 cfm

Stripper Max Flow: 500 gpm

Water Results

Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray % Removal	6-Tray Results (ppb)	6-Tray % Removal
tetrachloroethylene (PERC,PCE)	350	5	< 1	100.000	< 1	100.000

Air Results

Contaminant	4-Tray (ppmV)	4-Tray (lb/hr)	6-Tray (ppmV)	6-Tray (lb/hr)
tetrachloroethylene (PERC,PCE)	1.2596	0.08756	1.2606	0.08762

Notes

PH-> 1-800-624-2026 or 1-734-995-2547, FX-> 1-734-995-1170. E-mail->info@qedenv.com. WEB->www.qedenv.com.

The QED modeler estimates unit performance for the listed contaminants.
Results assume -

1. *dissolved-phase contaminant within a water matrix*
2. *clean stripper air*
3. *no surfactants, oil, grease or other immiscible phase(s) in the influent*
4. *unit operated within the given parameters and as instructed in the O&M manual*

Stripper performance shall meet or exceed either the required effluent concentration(s) or effluent estimates, whichever is greater, for the conditions supplied and assumes the influent concentrations of each contaminant are less than 25% solubility in water. QED makes no claim of the model's accuracy beyond the 25% solubility in water limit.

QED Air Stripper Model ver. 2.01	11/9/2010

Site Data

Name: Crystal

e-mail: celeste.foster@aecom.com

Project: On 2

Units: English

Altitude: 50 ft

Air Temp: 50 F

Flow: 1000 gpm

Water Temp: 50 F

Stripper: EZ-Tray 96.x - Click for details

Stripper Air Flow: 5200 cfm

Stripper Max Flow: 1000 gpm

Water Results

Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray % Removal	6-Tray Results (ppb)	6-Tray % Removal
tetrachloroethylene (PERC,PCE)	350	5	< 1	100.000	< 1	100.000

Air Results

Contaminant	4-Tray (ppmV)	4-Tray (lb/hr)	6-Tray (ppmV)	6-Tray (lb/hr)
tetrachloroethylene (PERC,PCE)	1.2596	0.17512	1.2606	0.17525

Notes

PH-> 1-800-624-2026 or 1-734-995-2547, FX-> 1-734-995-1170. E-mail->info@qedenv.com. WEB->www.qedenv.com.

The QED modeler estimates unit performance for the listed contaminants.
Results assume -

1. *dissolved-phase contaminant within a water matrix*
2. *clean stripper air*
3. *no surfactants, oil, grease or other immiscible phase(s) in the influent*
4. *unit operated within the given parameters and as instructed in the O&M manual*

Stripper performance shall meet or exceed either the required effluent concentration(s) or effluent estimates, whichever is greater, for the conditions supplied and assumes the influent concentrations of each contaminant are less than 25% solubility in water. QED makes no claim of the model's accuracy beyond the 25% solubility in water limit.

QED Air Stripper Model ver. 2.01	11/9/2010

Site Data

Name: Crystal

e-mail: celeste.foster@aecom.com

Project: Off

Units: English

Altitude: 50 ft

Air Temp: 50 F

Flow: 700 gpm

Water Temp: 50 F

Stripper: EZ-Tray 72.x - Click for details

Stripper Air Flow: 3800 cfm

Stripper Max Flow: 750 gpm

Water Results

Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray % Removal	6-Tray Results (ppb)	6-Tray % Removal
tetrachloroethylene (PERC,PCE)	15	5	< 1	100.000	< 1	100.000

Air Results

Contaminant	4-Tray (ppmV)	4-Tray (lb/hr)	6-Tray (ppmV)	6-Tray (lb/hr)
tetrachloroethylene (PERC,PCE)	0.0517	0.00525	0.0517	0.00526

Notes

PH-> 1-800-624-2026 or 1-734-995-2547, FX-> 1-734-995-1170. E-mail->info@qedenv.com. WEB->www.qedenv.com.

The QED modeler estimates unit performance for the listed contaminants. ***Results assume -***

1. *dissolved-phase contaminant within a water matrix*
2. *clean stripper air*
3. *no surfactants, oil, grease or other immiscible phase(s) in the influent*
4. *unit operated within the given parameters and as instructed in the O&M manual*

Stripper performance shall meet or exceed either the required effluent concentration(s) or effluent estimates, whichever is greater, for the conditions supplied and assumes the influent concentrations of each contaminant are less than 25% solubility in water. QED makes no claim of the model's accuracy beyond the 25% solubility in water limit.

Contact Us

Fill out your contact and project information and click Send to have a QED Treatment

application specialist contact you.

Name -	Crystal		
Company -	Company		
Phone -	Phone	**Fax -**	Fax
e-mail -	celeste.foster@aecom.com	**Project -**	Off

Application Notes

Send Reset

Save Data

Use the following URL to reconstruct your data form for future remodeling with changes. This URL can be saved in any text file for record keeping and later retrieval. This run's URL:

```
http://64.9.214.199/cgi-bin/remodel.pl?
u=e&tw=50&ta=50&f=700&a=50&s=72.x&n=Cryst&e=celeste.foster@aecom.com&
p=Off&c=182,15;
```

Delta Cooling Towers, Inc.
41 Pine Street
Rockaway, New Jersey 07866-0315
Telephone 973-586-2201x116
Fax 973-586-2243
Email: sales@deltacooling.com
Web Address: www.deltacooling.com
Delta Cooling Towers

VANGUARD®

October 28, 2010

Claire Hunt
claire.hunt@aecom.com

AECOM
100 Red Schoolhouse Road, Suite B-1
Chestnut Ridge , NY 10977-6715
T 845.425.4980 x21 F 845.425.4989
www.aecom.com

Subject: Delta Project # B10-056

Dear Ms. Hunt,

Thank you for the opportunity to submit this Delta Air Stripper proposal for your consideration. In response to your request, Delta recommends the following equipment for this application.

THIS SCOPE IS TYPICAL FOR ALL 9 OPTIONS. IT IS BASED ON OPTION#1 BUT CAN BE APPLIED TO ALL OTHER 8…

Option #1 - Design Basis - (1) Tower at 200gpm per Tower @ 50°F

Design Contaminant	Required Removal Efficiency	Calculated Removal Efficiency
PCE	99.3%	99.3%+

Packed Tower Air Stripping System

Delta recommends One (1) of our Vanguard® Model ∆S3-250DF air strippers for the subject application. The stripper is a 36" diameter Fiberglass column with 25'-0" of DeltaPAK® Structured Packing, shop installed prior to shipment. The tower shell will be fabricated from NSF Approved FRP and will include the necessary wall re-distribution rings and shell body flanges.

NOTE: All internals are pre-installed by Delta Prior to Shipment.

The other items included in Delta Cooling Towers, Inc.'s scope of supply for this project are (per tower):

- The tower will include One (1) 1.0hp TEFC 230/460/3/60 blower/motor assembly designed for 1,070cfm @ 3.5"w.c.
- The blower will be supplied with the intake filter, inlet louver, air flow

measuring station, blower inlet and outlet flexible connections, and ductwork from the blower to the tower. All ductwork material is Aluminum.

- The tower column will be provided with the flanges, nozzles, connections and manways.
- The tower will also be supplied with the required internals; FRP packing support plates, PVC mist eliminators, and PVC / Stainless Steel inlet distribution systems.
- A 3.5” Schedule 80 PVC influent pipe terminating at a flange approximately 5’-0” above the base of the stripper, and a 4” effluent flanged end FRP nozzle connection (side discharge).
- Blower Pressure Switch.
- Filter housing and packing bed differential pressure gauges
- Basic NEMA 3R Control Panel
- Design of the tower anchor bolts is by Delta Cooling Towers, Inc., the supply and installation of the bolts required are by others.
- All the necessary drawings, submittals for approval and O&M manuals.

The following items are specifically **excluded** for this proposal:

- Offloading or installation labor.
- Insulation Materials of any Type.
- Anchor Bolts.
- Controls or Instrumentation other than specifically listed above.
- Any and all taxes.

The total net price for the One (1) FRP air stripping tower is $(See Spreadsheet), FOB Philippi, W.V., Freight PP&A. Shipment can be made approximately 10 weeks after receipt of “Approved” submittals and authorization to proceed with fabrication. Please allow 2 weeks for preparation of submittals. Price is exclusive of any and all taxes.

Please feel free to contact the undersigned with any questions or comments. Thank you for your interest in Delta and its products, and for the opportunity to be of service.

Sincerely,

Joseph B. Homza, Jr.

Joseph B. Homza, Jr.
Vice President – Municipal Products Division

AECOM Budget Project
Delta Project Number B10-056
10/28/2010

Site Name	Country On-Site A	Country On-Site B	Country On-Site C	Country Supply Well 1	Country Supply Well 2	Crystal On-Site A	Crystal On-Site B	Crystal On-Site C	Crystal Supply Well 1
Flow Rate (GPM)	200	1000	5000	650	1500	500	1000	5000	700
Temperature (°F)	50	50	50	50	50	50	50	50	50
PCE Removal Efficiency Required	99.30%	99.30%	99.30%	50.00%	50.00%	98.60%	98.60%	98.60%	66.70%
PCE Removal Efficiency Calculated	99.3%+	99.3%+	99.3%+	90%+	90%+	98.6%+	98.6%+	98.6%+	90%+
Tower Model	S3-250DF	S7-250DF	S10-260DF	S6-120DF	S8-120DF	S4.5-230DF	S7-210DF	S10-220DF	S6-120DF
Number of Towers	1	1	2	1	1	1	1	2	1
Diameter	36"	84"	120"	72"	96"	54"	84"	120"	72"
Packing Depth	25'-0"	25'-0"	26'-0"	12'-0"	12'-0"	23'-0"	21'-0"	22'-0"	12'-0"
Blower HP	1	5	10	3	7.5	2	5	10	3
Blower Air Flow (CFM)	1,070	5,350	13,670	3,475	8,025	2,675	5,350	13,670	3,745
Inlet Pipe Size	3.5"	8"	12"	6"	10"	6"	8"	12"	8"
Outlet Pipe Size	4"	10"	14"	8"	12"	8"	10"	14"	8"
NEMA 3RControl Panel Included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pumping Included	No	No	No	No	No	No	No	No	No
Freight	PP&A	PP&A	PP&A	PP&A	PP&A	PP&A	PP&A	PP&A	PP&A
			(each)					(each)	
BUDGET PRICE	$65,000	$110,000	$160,000	$90,000	$100,000	$75,000	$100,000	$150,000	$90,000

Delta Cooling Towers, Inc.

41 Pine Street · P.O. Box 315 · Rockaway, NJ 07866-0315
Phone: 973.586.2201 · Fax: 973.586.2243
Website: http://www.deltacooling.com

Delta-Pak® Structured Packing.

The PVC **Delta-Pak**® structured packing is a proprietary product, which offers unusually low air static pressure losses and provides high mass transfer efficiency.

The honeycomb-like construction allows for high air velocities for applications that demand it, and defers water loading "flooding points" well beyond typical maximum levels of random type packings.

Delta-Pak® structured packing is installed in homogeneous circular layers of nominal 12" and 6" high layers. The packing layers only weight about 2 lb/cu. ft. and can be easily handled.

Delta-Pak® structured packing can be cleaned chemically, as long as the limits of PVC corrosion and chemical resistance is respected.

If replacement of **Delta-Pak**® packing becomes necessary, the layers can be removed through the top of the air stripper column. The water distribution system can be removed to allow for packing removal. When the air stripper column is supplied as flanged sections, each packed section can be disassembled and lowered for easy access at grade level. The packing layers can be compressed in the radial direction if tight clearances are encountered, and will "spring back" to its original shape.

Do not step directly on the packing surface. Crushing of the edges of the PVC corrugations will inhibit proper air flow and water distribution, and as a result reduce performance.

If it is necessary to stand on the packing surface use a piece of plywood or similar protection to distribute weight over a greater surface. Maximum weight distribution is 80 lbs/sq. ft.

Do not stand on any packing inside a stripping tower unless it is absolutely necessary and unless proper judgment is exercised regarding the supporting capability of the packing.

Delta Cooling Towers, Inc.

41 Pine Street · P.O. Box 315 · Rockaway, NJ 07866-0315
Phone: 973.586.2201 · Fax: 973.586.2243
Website: http://www.deltacooling.com

Packing. **Delta-Pak**®, used in all standard stripper models, is a high performance structured packing constructed of Type 1 PVC material protected against UV degradation.

Applicable data below is for air - water atmospheric system:

Surface area:	90 sq. ft./cu.ft.
Void space:	Higher than 98%
Open cross-section:	Higher than 98%
Maximum air flow before flooding, at 20 gpm/sq.ft.:	750 scfm/sq.ft. or higher
Static pressure loss at 20 gpm/sq.ft. and 500 scfm/ sq.ft. air flow:	0.10 in. W.C./ft. or lower
Orientation of corrugation:	Vertical ("see - through")
Nominal corrugation size:	Approx. 3/4 in.
"Channelling" characteristics:	No channeling occurs. Packing construction prevents any radial transfer of mass, due to its spirally wound configuration. Transfer in tangential direction is negligible. No redistribution devices are required.
"Clogging" and "fouling" characteristics:	The absence of any horizontally orientated surfaces reduces accumulation of precipitates and deposition of suspended solids. Most solids including precipitates pass freely through vertical corrugations.
Standard packing layer heights:	12.6 in. and 6.3 in.

Delta Cooling Towers, Inc.

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DELTA-PAK® STRUCTURED PACKING BENEFITS

HIGH IRON OR CALCIUM CONTENT

Concentrations of dissolved iron in ground water (in excess of 2 mg/l) has the potential to foul process equipment. High iron content water will combine with dissolved oxygen and precipitate, causing pumps, infiltration galleries, feed lines and packing media to foul.

Precipitation occurs primarily at the nozzle or inlet distribution area of an air stripper, where water mixes with the counter flowing air stream. Iron and calcium precipitate accumulates and hardens on all surfaces of packing. This precipitate will subsequently need to be removed, which is most effectively and economically removed in place. When properly cleaned, the particulate which sloughs off upper sections of random packings and may tend to "hang up" at lower levels of the packing bed. This accumulation, if not managed, can lead towards performance failure, media failure or even worse tower structural failure.

Delta-Pak® structured packing, since it does not have horizontal or angled surfaces, resists iron precipitate accumulation and therefore will operate efficiently for much longer periods between requiring chemical cleaning. In past applications **Delta-Pak**® structured packing has successfully performed four to six times longer than random packing it has replaced before having to be cleaned. The particulate which sloughs off the packing will flush straight through the media to the sump.

Delta-Pak® structured packing is recommended for applications where high iron or calcium levels are present in the process flow. Although the degree of fouling and frequency of required cleaning is site specific, it is generally recommended that
Delta-Pak® structured packing be used for iron or calcium levels above 2 mg/l.

3-D MicroEmulsion™
HRC ADVANCED®

ACHIEVE WIDE-AREA, RAPID AND SUSTAINED REDUCTIVE DECHLORINATION WITH CONTINUOUS DISTRIBUTION AND STAGED HYDROGEN RELEASE

PRODUCT FEATURES

- **Three Stage Electron Donor Release – Immediate, Mid-Range and Long- Term Hydrogen Production**
  Provides free lactic acid, controlled release lactic acid and long release fatty acids for effective hydrogen production for periods of of up to 3 to 5 years.

- **Low-Cost**
  3-D Microemulsion is 25¢ to 42¢ per pound as applied.

- **Maximum and Continuous Distribution via Micellar Transport**
  Unlike oil products, 3DMe forms micelles which are mobile in groundwater and significantly enhance electron donor distribution after injection.

- **Wide-Area/High Volume Microemulsion Application**
  High volume application increases contact with contaminants and reduces number of injection points required for treatment – minimizes overall project cost.

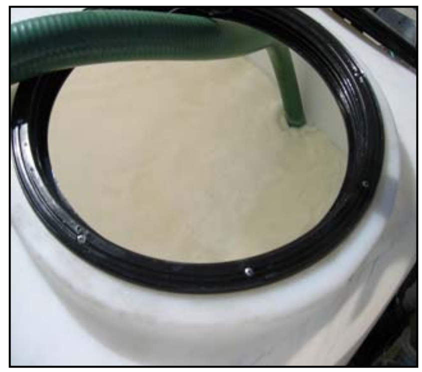


Photo 1. 3DMe™ prior to injection

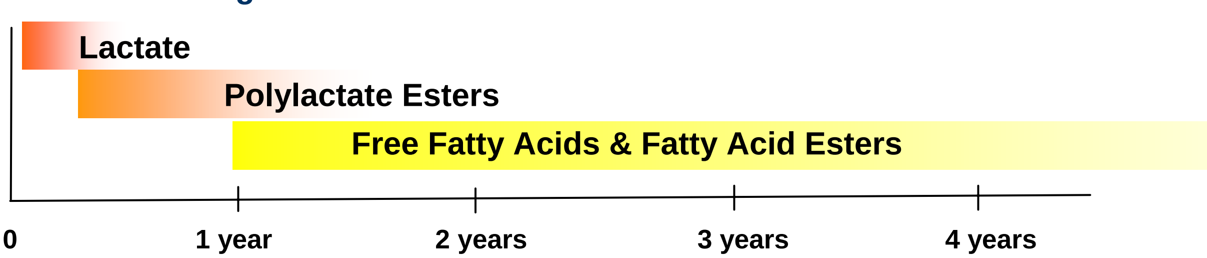
PRODUCT COMPOSITION

3-D Microemulsion (3DMe)™ formerly known as HRC Advanced™ has a molecular structure specifically designed to maximize the cost-effective anaerobic treatment of contaminants in subsurface soils and groundwater. This structure (patent pending) is composed of free lactic acid, controlled-release lactic acid (polylactate) and certain fatty acid components which are esterified to a carbon backbone molecule of glycerin..

3DMe produces a sequential, staged release of its electron donor components. The immediately available, free lactic acid, is fermented rapidly while the controlled release lactic acid is metabolized at a more controlled rate. The fatty acids are converted to hydrogen over a mid to long-range timeline giving 3DMe an exceptionally long electron donor release profile (Figure 1). This staged fermentation provides an immediate, mid-range and very long-term, controlled-release supply of hydrogen (electron donor) to fuel the reductive dechlorination process.

Typical 3DMe single application longevity is rated to between 3 and 5 years. With 5 years occurring under optimal conditions, e.g. low permeability, low consumption environments.

Figure 1. 3-D Microemulsion™ Release Profile



REGENESIS
Advanced Technologies for Groundwater Resources

APPLICATION AND DISTRIBUTION

3DMe applications can be configured in several different ways including: **grids, barriers and excavations.** The material itself can be applied to the subsurface through the use of **direct-push injection, hollow-stem auger, existing wells** or **re-injection wells.**

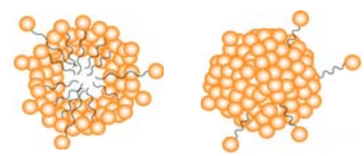
3DMe is typically applied in high-volumes as an emulsified, micellar suspension (microemulsion). The microemulsion is easily pumped into the subsurface and is produced on-site by mixing specified volumes of water and delivered 3DMe concentrate. Detailed preparation and installation instructions are available at www.regenesis.com.

3DMe is usually applied throughout the entire vertical thickness of the determined treatment area. Once injected, the emulsified material moves out into the subsurface pore spaces via micellar transport, eventually coating most all available surfaces. Over time the released soluble components of 3D Microemulsion are distributed within the aquifer via the physical process of advection and the concentration driven forces of diffusion.

More on Micelles

Micelles (Figure 2.) are groups (spheres) of molecules with the hydrophilic group facing out to the water and the “tails” or lipophilic moiety facing in. They are formed during the 3-D Microemulsion emulsification process and provide the added benefit of increased distribution via migration to areas of lower concentration.

Figure 2: Micelle Representation



MORE ON APPLICATIONS

3DMe is typically applied in large volumes and is easily injected using widely available, non-specialized remediation equipment.

3-D Microemulsion is delivered in 55 gallon drums, 300 gallon totes, tankers or buckets.

The microemulsion is easily prepared on-site and applied in high volumes for adequate subsurface distribution.

The material can be easily applied through existing wells or direct push-points.

PERFORMANCE

Case Study #1

A site in Massachusetts showed high levels of PCE and its daughter products TCE and cis-DCE which had been consistently present for more than two years. 3DMe was applied in a grid configuration around monitoring well #16. In Figure 3, the contaminant concentration results indicate a rapid decrease in the parent product PCE and evidence of reductive dechlorination as demonstrated by the relative increases in daughter products TCE and cis-DCE.

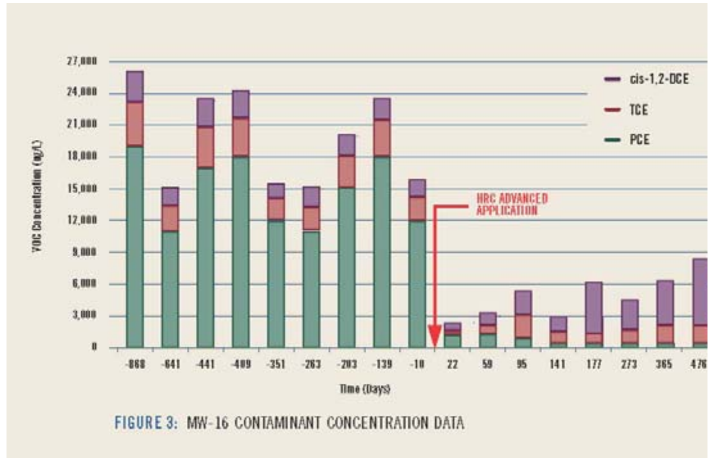


Figure 3. MW-16 Contaminant Concentration Data

Case Study #2

A site in Florida was characterized with PCE Contamination Approaching 225 ug/L. 1080 pounds of HRC Advanced was applied in a grid configuration through 16 direct-push points, with about 5 feet between each point and at a rate of approximately 5 lbs. per vertical foot. Monitoring in well 103 at 75 days post-3DMe injection indicated that PCE was reduced by 67% then leveled off for about 75 days then dropped another 22% for a total of 89% reduction over a 275 day period. TOC levels remain elevated at 17-19 mg/L after 275 days and daughter products remain at low levels (Figure 4).

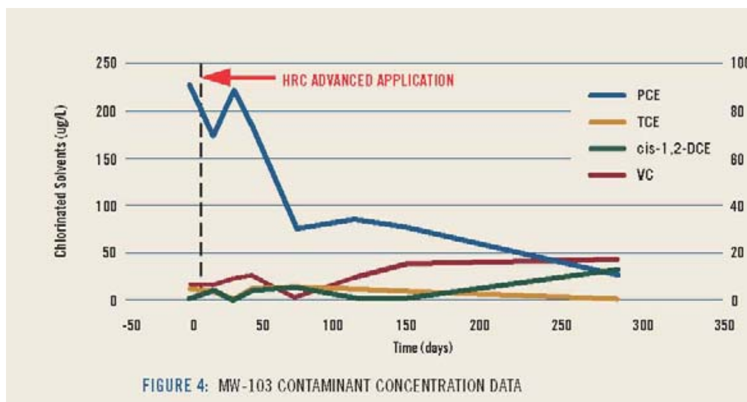


Figure 4. MW-103 Contaminant Concentration Data

For more information on 3-D Microemulsion, contact you local representative or call 949-366-8000.
You can also visit our website at www.regenesis.com.

REGENESIS
Advanced Technologies for Groundwater Resources

ͻMe Barrier Treatment Summary Page - Consultant Output

ͺgenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Location: downgradient barrier

Consultant: AECOM

Aquifer Characteristics

Soil Type	silty sand	
Effective Porosity	0.2	
Hydraulic Conductivity	10	ft/day
Hydraulic Gradient	0.005	ft/ft
Seepage Velocity	91.3125	ft/yr

Design Assumptions

Length of Barrier	100	ft
Thickness of Application	30	ft
Dissolved Contaminant Mass	3.42	lbs/yr
Mass of Competing Electron Acceptors	222.32	lbs/yr

3DMe Barrier Treatment Summary Page - Consultant Output

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name:

Location:

Consultant:

Direct Push Injection Application

Me-Related

ncentrate Mass	1,230	lbs
ncentrate Volume	148	gals

Base 10:1 Emulsion Formulation

3DMe Concentrate Volume	148	gals
Water Volume	1,474	gals
Emulsion Total Volume	1,622	gals

Recommended Emulsion Formulation

Additional Water Volume	9,150	gals
Total Water Volume (base+recommended)	10,624	gals
Total Mass of Recommended Emulsion	89,891	lbs
Total Volume of Recommended Emulsion	10,772	gals
Percentage of Effective Pore Space Used	12.0%	

Application-Related

Number of Direct Push Injection Points	9	points
Mass of 3DMe 10:1 Base Emulsion per Point	1,503	lbs/point
Volume of 3DMe 10:1 Base Emulsion per Point	180.2	gals/point
Mass of 3DMe 10:1 Base Emulsion per Lineal Foot	50	lbs/ft
Volume of Recommended Emulsion per Point	1,197	gals/point
Volume of Recommended Emulsion per Foot	39.9	gals/ft
Estimated Application Rate	5	gpm
Estimated Application Time per Point	8	min/point

Purchasing-Related Information

Number of Buckets of 3DMe Concentrate	41	buckets
Estimated Number of Pallets	2	pallets
Total Required Volume of Water	10,624	gals
Mass of 10:1 Base Emulsion	13,530	lbs
Unit Price ($/lb) of 10:1 Base Emulsion	$ 0.41	
Material Cost at 10:1 Base Emulsion (total)	$ 5,547	
Sales Tax	$ -	
Shipping Estimate	$ -	Call Regenesis For Quote

3DMe Barrier Treatment Summary Page - Consultant Output

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name:
Location:
Consultant:

Fixed Well Application

3DMe-Related		
Concentrate Mass	1,230	lbs
Concentrate Volume	148	gals
Base 10:1 Emulsion Formulation		
3DMe Concentrate Volume	148	gals
Water Volume	1,474	gals
Emulsion Total Volume	1,622	gals
Recommended Emulsion Formulation		
Additional Water Volume	9,150	gals
Total Water Volume (base+recommended)	10,624	gals
Total Mass of Recommended Emulsion	89,891	lbs
Total Volume of Recommended Emulsion	10,772	gals
Percentage of Effective Pore Space Used	12.0%	
Application-Related		
nber of Wells	9	wells
ss of 3DMe 10:1 Base Emulsion per Well	1,503	lbs/well
ume of 3DMe 10:1 Base Emulsion per Well	180.2	gals/well
ss of 3DMe 10:1 Base Emulsion per Lineal Foot	50	lbs/ft
ume of Recommended Emulsion per Well	1,197	gals/well
Volume of Recommended Emulsion per Foot	39.9	gals/ft
Estimated Application Rate	10	gpm
Estimated Application Time per Point	12	min/point
Purchasing-Related Information		
Number of Buckets of 3DMe Concentrate	41	buckets
Estimated Number of Pallets	2	pallets
Total Required Volume of Water	10,624	gals
Mass of 10:1 Base Emulsion	13,530	lbs
Unit Price ($/lb) of 10:1 Base Emulsion	$ 0.41	
Material Cost at 10:1 Base Emulsion (total)	$ 5,547	
Sales Tax	$ -	
Shipping Estimate	$ -	Call Regenesis For Quote

3DMe Barrier Treatment Summary Page - Contractor Output

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name:
Location:
Consultant:

Direct Push Application

Aquifer-Related Information		
Soil Type	silty sand	
Application Dimensions		
Length of Barrier	100	ft
Thickness of Application	30	ft
3DMe-Related Information		
3DMe Concentrate Mass	1,230	lbs
Number of Buckets of 3DMe Concentrate	41	buckets
Estimated Number of Pallets	2	pallets
Base 10:1 Vol:Vol Emulsion Water Requirement	1,474	gals
Additional Water Needed to Make Emulsion	9,150	gals
Total Volume of Water Required	10,624	gals
Application-Related Information		
Number of Rows in Barrier	1	rows
Spacing Within Rows	12	ft
Spacing Between Rows	10	ft
Number of Direct Push Injection Points	9	points
Volume of 3DMe As Applied, Emulsion per Point	1,197	gals/point
Volume of 3DMe As Applied, Emulsion per Foot	39.9	gals/ft
Estimated Application Rate	5	gals/minute
Estimated Application Time per Point	8	min/point
Purchasing-Related Information		
Number of Buckets of 3DMe Concentrate	41	buckets
Estimated Number of Pallets	2	pallets
Total Required Volume of Water	10,624	gals

3DMe Barrier Treatment Summary Page - Contractor Output

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name:
Location:

‹ed Well Application

Aquifer-Related Information		
Soil Type	silty sand	
Application Dimensions		
Length of Barrier	100	ft
Thickness of Application	30	ft
3DMe-Related Information		
3DMe Concentrate Mass	1,230	lbs
Number of Buckets of 3DMe Concentrate	41	buckets
Estimated Number of Pallets	2	pallets
Base 10:1 Vol:Vol Emulsion Water Requirement	1,474	gals
Additional Water Needed to Make Emulsion	9,150	gals
Total Volume of Water Required	10,624	gals
Application-Related Information		
Number of Rows in Barrier	1	rows
Spacing Within Rows	12	ft
Spacing Between Rows	10	ft
Number of Injection Wells	9	wells
Volume of 3DMe As Applied, Emulsion per Well	1,197	gals/well
Volume of 3DMe As Applied, Emulsion per Foot	39.9	gals/ft
Estimated Application Rate	10	gals/minute
Estimated Application Time per Well	12	min/well
Purchasing-Related Information		
Number of Buckets of 3DMe Concentrate	41	buckets
Estimated Number of Pallets	2	pallets
Total Required Volume of Water	10,624	gals

...)Me Grid Treatment Summary Page - Consultant Output

...genesis Technical Support: USA (949) 366-8000 www.regenesis.com

...untry cleaner Hintington NY

Location: Area around cleaner

Consultant: aecom

Aquifer Characteristics

Soil Type	silty sand	
Total Porosity	0.4	
Effective Porosity	0.2	
Hydraulic Conductivity	10	ft/day
Hydraulic Gradient	0.005	ft/ft
Seepage Velocity	91.3	ft/yr
Pore Volume	58,800	ft^3
Pore Volume	439,855	gals

Design Assumptions

Area of Application	4,900	ft^2
Thickness of Application	30	ft
Dissolved Contaminant Mass	2.68	lbs
Adsorbed Contaminant Mass	12.68	lbs
Mass of Competing Electron Acceptors	330.37	lbs

3DMe Grid Treatment Summary Page - Consultant Output

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Country cleaner Hintington NY
Location: Area around cleaner
Consultant: aecom

Direct Push Injection Application

3DMe-Related

Concentrate Mass	6,030	lbs
Concentrate Volume	723	gals

Base 10:1 Emulsion Formulation

3DMe Concentrate Volume	723	gals
Water Volume	7,226	gals
Emulsion Total Volume	7,949	gals
Effective Pore Space Displaced	3.6%	%

Recommended Emulsion Formulation

Additional Water Volume	849	gals
Total Water Volume (base+recommended)	8,074	gals
Total Mass of Recommended Emulsion	73,412	lbs
Total Volume of Recommended Emulsion	8,797	gals

Application-Related

Number of Direct Push Injection Points	25	points
Mass of 3DMe 10:1 Base Emulsion per Point	2653	lbs/point
Volume of 3DMe 10:1 Base Emulsion per Point	318	gals/point
Mass of 3DMe 10:1 Base Emulsion per Lineal Foot	88.4	lbs/ft
Volume of Recommended Emulsion per Point	352	gals/point
Volume of Recommended Emulsion per Foot	12	gals/ft
Estimated Application Rate	5	gpm
Estimated Application Time per Point	9	min/point

Purchasing-Related Information

Number of Buckets of 3DMe Concentrate	201	buckets
Estimated Number of Pallets	6	pallets
Total Required Volume of Water	8,074	gals
Mass of 10:1 Base Emulsion	66,330	lbs
Unit Price ($/lb) of 10:1 Base Emulsion	$ 0.41	
Material Cost at 10:1 Base Emulsion (total)	$ 27,195	
Sales Tax	$ -	
Shipping Estimate	$ -	Call Regenesis For Quote

3DMe Grid Treatment Summary Page - Consultant Output

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Country cleaner Hintington NY
Location: Area around cleaner
Consultant: aecom

Fixed Well Application

3DMe-Related		
Concentrate Mass	6,030	lbs
Concentrate Volume	723	gals
Base 10:1 Emulsion Formulation		
3DMe Concentrate Volume	723	gals
Water Volume	7,226	gals
Emulsion Total Volume	7,949	gals
Effective Pore Space Displaced	3.6%	%
Recommended Emulsion Formulation		
Additional Water Volume	849	gals
Total Water Volume (base+recommended)	8,074	gals
Total Mass of Recommended Emulsion	73,412	lbs
Total Volume of Recommended Emulsion	8,797	gals
Application-Related		
Number of Wells	25	wells
Mass of 3DMe 10:1 Base Emulsion per Well	2653	lbs/well
ume of 3DMe 10:1 Base Emulsion per Well	318	gals/well
ss of 3DMe 10:1 Base Emulsion per Lineal Foot	88.4	lbs/ft
ume of Recommended Emulsion per Well	352	gals/well
ume of Recommended Emulsion per Foot	12	gals/ft
Estimated Application Rate	10	gpm
Estimated Application Time per Well	4	min/well
Purchasing-Related Information		
Number of Buckets of 3DMe Concentrate	201	buckets
Estimated Number of Pallets	6	pallets
Total Required Volume of Water	8,074	gals
Mass of 10:1 Base Emulsion	66,330	lbs
Unit Price ($/lb) of 10:1 Base Emulsion	$ 0.41	
Material Cost at 10:1 Base Emulsion (total)	$ 27,195	
Sales Tax	$ -	
Shipping Estimate	$ -	Call Regenesis For Quote

3DMe Grid Treatment Summary Page - Contractor Output

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Country cleaner Hintington NY
Location: Area around cleaner
Consultant: aecom

Direct Push Application

Aquifer-Related Information		
Soil Type	silty sand	
Area of Application	4,900	ft^2
Application Dimensions		
Length	70	ft
Width	70	ft
Thickness	30	ft
3DMe-Related Information		
3DMe Concentrate Mass	6,030	lbs
Number of Buckets of 3DMe Concentrate	201	buckets
Estimated Number of Pallets	6	pallets
Base 10:1 Emulsion Water Requirement	7,226	gals
Additional Water Needed to Make Recom. Emulsion	849	gals
Total Volume of Water Required	8,074	gals
Application-Related Information		
Spacing Within Rows	15	ft
Spacing Between Rows	15	ft
Number of Direct Push Injection Points	25	points
Volume of 3DMe As Applied, Emulsion per Point	352	gals/point
Volume of 3DMe As Applied, Emulsion per Foot	12	gals/ft
Estimated Application Rate	5	gals/minute
Estimated Application Time Per Point	9	mins/point
Purchasing-Related Information		
Number of Buckets of 3DMe Concentrate	201	buckets
Estimated Number of Pallets	6	pallets
Total Required Volume of Water	8,074	gals
Mass of 10:1 Base Emulsion	66,330	lbs
Unit Price ($/lb) of 10:1 Base Emulsion	$ 0.41	
Sales Tax	$ -	
Shipping Estimate	$ -	Call Regenesis For Quote

3DMe Grid Treatment Summary Page - Contractor Output

genesis Technical Support: USA (949) 366-8000 www.regenesis.com

untry cleaner Hintington NY

a around cleaner

om

Fixed Well Application

Aquifer-Related Information		
Soil Type	silty sand	
Area of Application	4,900	ft^2
Application Dimensions		
Length	70	ft
Width	70	ft
Thickness	30	ft
3DMe-Related Information		
3DMe Concentrate Mass	6,030	lbs
Number of Buckets of 3DMe Concentrate	201	buckets
Estimated Number of Pallets	6	pallets
Base 10:1 Emulsion Water Requirement	7,226	gals
Additional Water Needed to Make Recom. Emulsion	849	gals
Total Volume of Water Required	8,074	gals
Application-Related Information		
Spacing Within Rows	15	ft
Spacing Between Rows	15	ft
Number of Injection Wells	25	points
Volume of 3DMe As Applied, Emulsion per Well	352	gals/point
Volume of 3DMe As Applied, Emulsion per Foot	12	gals/ft
Estimated Application Rate	10	gals/minute
Estimated Application Time Per Point	4	mins/point
Purchasing-Related Information		
Number of Buckets of 3DMe Concentrate	201	buckets
Estimated Number of Pallets	6	pallets
Total Required Volume of Water	8,074	gals
Mass of 10:1 Base Emulsion	66,330	lbs
Unit Price ($/lb) of 10:1 Base Emulsion	$ 0.41	
Sales Tax	$ -	
Shipping Estimate	$ -	Call Regenesis For Quote

Country Cleaners

Site Management Plans	$20,000
Periodic Review Reports	$25,000

Groundwater Sampling Event					$28,443
Items	U/M	Qty	Unit Cost	Cost	
Field Effort	hrs	116	100	$11,600	
Documentation	hrs	100	100	$10,000	
Van rental	day	5	150	$750	
Equipment rental	ls	1	$2,400	$2,400	
Analytical Costs (HCV Invoice)	ls	1	$3,093	$3,093	
Travel & Incidental expenses	ls	1	$600	$600	

Notes:
Low flow sampling of 15 wells
15 for voc analyses, 3 for MNA parameters
Three wells sampled per day, 5 day event
2 people, 10 hour days inc. travel

Deed Restriction

Deed Restriction					$25,000
Items	U/M	Qty	Unit Cost	Cost	
Field Effort	hrs	250	100	$25,000	

Ex Situ Installation

Extraction and Injection Well Installation					$82,142
and Connection to Sanitary Sewer					
Items	U/M	Qty	Unit Cost	Cost	
Pre-Design Study	hrs	200	$100	$20,000	
Mob/Demob	ls	1	$10,000	$10,000	
Utility Clearance	ls	1	$1,800	$1,800	
2 Extraction wells					
Well Drilling	ft	160	$30	$4,800	
Screen	ft	60	$30	$1,800	
Riser Pipe	ft	100	$50	$5,000	
box	ea	2	$300	$600	
Pump Installation	hrs	16	$155	$2,480	
Pumps	ea	2	$5,582	$11,164	
2 Injection wells					
Well Drilling	ft	120	$50	$6,000	
Screen	ft	60	$90	$5,400	
Riser Pipe	ft	60	$50	$3,000	
box	ea	2	$300	$600	
Standby	hrs	8	$155	$1,240	
Soil Disposal Costs					
Lab Testing	ls	1	$1,000	$1,000	
Disposal of 55 gal drums	drum	50	$73	$3,650	
QA/QC Fee	ls	1	$40	$40	
Manifest Prep Fee	ls	1	$50	$50	
Label Prep Fee	ls	1	$425	$425	
Reg. Admin Fee	ls	1	$336	$336	
Transporation	ls	1	$1,694	$1,694	
Demurrage	ls	1	$450	$450	
Tax (8.625%)	% total	$6,645	$0.08625	$573	
NJ Recycling Tax	ls	1	$40	$40	
Contractors for installation of piping/electrical					$72,160
to treatment and connection to stormwater basin					
Plumber Certified in Town	hrs	24	$200	$4,800	
Electrician Certified in Town	hrs	16	$200	$3,200	
Contractor	hrs	120	$300	$36,000	
Backhoe	day	2	$1,500	$3,000	
Mob/Demob	ls	1	$5,000	$5,000	
Materials	%	8%	$52,000	$4,160	
Road Opening Permits	ls	1	$1,000	$1,000	
SPDES permit compliance	hrs	150	$100	$15,000	
Treatment System					$89,380
Delta Cooling Towers Estimate					
System	ls	1	$65,000	$65,000	
Freight	ls	1	$10,000	$10,000	

Ex Situ Installation

Installation& Startup	hrs	72	$100	$7,200
Materials	%	2%	$65,000	$1,300
Tax	%	8%	$73,500	$5,880

Quote from Dean Bennett $5,582

Items	U/M	Qty	Unit Cost	Cost
Pump	ea	1	$2,541	$2,541
Tax	%	8%	$2,541	$203
Shipping	ls	1	$500	$500

In Situ Installation

Pilot Study					$20,000
Items	U/M	Qty	Unit Cost	Cost	
Pilot Study	ls	1	$20,000	$20,000	

Drilling					$144,220
Items	U/M	Qty	Unit Cost	Cost	
Utility Clearance	ls	1	$1,800	$1,800	
Initial -Enhanced Bio - Drilling - direct push assumed					
Mob/demob	ls	1	$2,000	$2,000	
Day Rate	day	16	$3,200	$51,200	
In excess of 8hr day	day	4	$185	$740	
Pressure Washer	day	16	$155	$2,480	
Initial ChemOx - Drilling - direct push assumed					
Mob/demob	ls	1	$2,000	$2,000	
Day Rate	day	12	$3,200	$38,400	
In excess of 8hr day	day	4	$185	$740	
Pressure Washer	day	12	$155	$1,860	
Polishing ChemOx - Drilling - direct push assumed					
Mob/demob	ls	1	$2,000	$2,000	
Day Rate	day	12	$3,200	$38,400	
In excess of 8hr day	day	4	$185	$740	
Pressure Washer	day	12	$155	$1,860	

Chemicals					$103,558
Items	U/M	Qty	Unit Cost	Cost	
Source area					
Micro-emulsion	ls	1	$27,195	$27,195	
Primer	ls	1	$4,200	$4,200	
Chemical Oxidation	ls	2	$25,200	$50,400	
Barrier					
Micro-emulsion	ls	1	$5,535	$5,535	
Primer	ls	1	$2,268	$2,268	
Tax				$8,960	
Shipping				$5,000	
Notes:					
Drilling Injections / day		2			

Supply Well Treatment System

Treatment System Equipment, Installation and Startup

650 gpm Supply Well					$122,268
Items	U/M	Qty	Unit Cost	Cost	
System	ls	1	$90,000	$90,000	
Installation&Startup	hr	120	$100	$12,000	
Materials	%	5%	$102,000	$5,100	
Tax	%	8%	$107,100	$8,568	
Freight	ls	1	$5,000	$5,000	
Electrician	hr	16	$100	$1,600	

1500 gpm Supply Well					$133,608
Items	U/M	Qty	Unit Cost	Cost	
System	ls	1	$100,000	$100,000	
Installation&Startup	hr	120	$100	$12,000	
Materials	%	5%	$112,000	$5,600	
Tax	%	8%	$117,600	$9,408	
Freight	ls	1	$5,000	$5,000	
Electrician	hr	16	$100	$1,600	

DEAN BENNETT SUPPLY COMPANY

QUOTE

1770 East 69th Avenue Denver. CO 80229-7327
Phone (303) 286-1500 FAX: (303) 286-0001
Website: www.deanbennett.com E-mail: pumpsdbs@aol.com
Nation Wide Toll Free (800) 621-4291

Quote	0004646
Date	10/29/2010
Page	1

Bill To:

JOHN CROFT'S QUOTATIONS
PLEASE ASK FOR JOHN CROFT &
REFER TO THIS QUOTE NUMBER
WHEN PLACING YOUR ORDER.

Ship To:

AECOM/ CLAIRE HUNT
845-425-4980
WHEN PLACING YOUR ORDER.

Purchase Order No.	Customer ID	Salesperson ID	Shipping Method	Payment Terms	Req Ship Date	Master No.
AECOM/ CLAIRE HUNT	80229JOHNCRO	JOHN	TRUCK LINE	PREPAID	0/0/0000	40,187

Quantity	Item Number	Description	UOM	Unit Price	Ext. Price
1	4F85S50	85 gpm Pump End Assembly for 5 hp	Each	$1,112.00	$1,112.00
1	137456	5 hp 230 volt 3-wire Franklin Motor	Each	$1,080.00	$1,080.00
1	135269	5 hp 230 volt Delux Control Box w/ contactor	Each	$294.00	$294.00
1	20M20FBCV	2" Male x 2" Female Brass Check Valve	Each	$55.95	$55.95

FIGURED AT 30 PSI 85' DEEP STATIC 46' 100 GPM
RECOVERY. THIS IS FOR WELL # MW-2D

Subtotal	$2,541.95
Misc	$0.00
Tax	$0.00
Freight	$0.00
Trade Discount	$0.00
Total	$2,541.95

DEAN BENNETT SUPPLY COMPANY

QUOTE

1770 East 69th Avenue Denver. CO 80229-7327
Phone (303) 286-1500 FAX: (303) 286-0001
Website: www.deanbennett.com E-mail: pumpsdbs@aol.com
Nation Wide Toll Free (800) 621-4291

Quote	0004647
Date	10/29/2010
Page	1

Bill To:

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PLEASE ASK FOR JOHN CROFT &
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WHEN PLACING YOUR ORDER.

Ship To:

JOHN CROFT'S QUOTATIONS
AECOM/CLAIRE HUNT
845-425-4980
WHEN PLACING YOUR ORDER.

Purchase Order No.	Customer ID	Salesperson ID	Shipping Method	Payment Terms	Req Ship Date	Master No.
AECOM/CLAIRE HUNT	80229JOHNCRO	JOHN	TRUCK LINE	PREPAID	0/0/0000	40,188

Quantity	Item Number	Description	UOM	Unit Price	Ext. Price
1	LINE	Line	Each	$2,099.00	$2,099.00
		500S15HP86 PUMP END ONLY. ALL STAINLESS STEEL			
1	126555	15HP 230Volt Three Phase Motor	Each	$2,015.00	$2,015.00
1	40DICV	4" Ductile Iron Check Valve for Deep Settings	Each	$433.00	$433.00

WILL NEED MIN. 8" ID CASING. 50' DEEP STATIC 14'
500 GPM RECOVERY

Subtotal	$4,547.00
Misc	$0.00
Tax	$0.00
Freight	$0.00
Trade Discount	$0.00
Total	$4,547.00