NOVEMBER 2021

New York State Department of Environmental Conservation
Division of Environmental Remediation

123 Post Ave - Operable Unit 2

Site No. 130088

Feasibility Study Report

D&B ENGINEERS AND ARCHITECTS

FEASIBILITY STUDY REPORT

123 POST AVENUE SITE - OPERABLE UNIT 2
WESTBURY, NEW YORK

SITE REGISTRY NO. 130088

WORK ASSIGNMENT NO. D007620-17

Prepared For

NEW YORK STATE DEPARTMENT
OF ENVIRONMENTAL CONSERVATION

By

D&B ENGINEERS AND ARCHITECTS
WOODBURY, NEW YORK

NOVEMBER 2021

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FEASIBILITY STUDY REPORT
123 POST AVENUE SITE - OPERABLE UNIT 2
WESTBURY, NEW YORK

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1.0 INTRODUCTION

This section presents the purpose of the feasibility study for the 123 Post Avenue site - Operable Unit 2 (OU2), a description of the site, summary of the remedial investigation results and risk assessment, definition of the remedial action objectives and approach to the feasibility study.

1.1 Purpose

As part of New York State's program to investigate and remediate hazardous waste sites, the New York State Department of Environmental Conservation (NYSDEC) issued a Work Assignment to D&B Engineers and Architects, P.C. (D&B) of Woodbury, New York, under its Superfund Standby Contract, to conduct a remedial investigation (RI) and feasibility study (FS) to evaluate groundwater quality downgradient of an active dry cleaning facility located at 123 Post Avenue in the Village of Westbury, Nassau County, New York. The off-site groundwater evaluation is being conducted as Operable Unit 2 (OU2) of the site.

The objectives of the OU2 RI/FS are to evaluate and characterize groundwater quality downgradient of the 123 Post Avenue site; determine the extent of off-site contamination; evaluate potential impacts to human health and the environment; determine the need for corrective action; identify and evaluate remedial alternatives; and select a long-term, cost-effective remediation plan.

This feasibility study has been prepared based on the results of the remedial investigation and in accordance with the federal Comprehensive Emergency Response, Compensation and Liability Act (CERCLA), Superfund Amendments and Reauthorization Act (SARA), and the New York State Superfund Program, including the NYSDEC Technical Guidance for Site Investigation and Remediation (DER-10).

1.2 Site Background

The site is an active dry-cleaning facility located at 123 Post Avenue in the Village of Westbury, Nassau County, New York. The site location and study area are shown on Figure 1-1. The dry cleaner property is approximately 0.2 acres in size and is bounded by a small shopping center to the north, the Long Island Railroad (LIRR) elevated tracks to the south, Post Avenue to the east, and an apartment complex to the west. As shown on Figure 1-1, the study area for OU2 extends from the site to south of the Meadowbrook State Parkway approximately 8,000 feet downgradient from the dry cleaner property. This portion of the study area south of the LIRR tracks and north of Old Country Road is primarily residential. Commercial businesses, an assisted living facility, offices and a parking lot occupy the western side of Post Avenue within the study area, and a LIRR station, cemeteries and a church occupy the eastern side of Post Avenue. Commercial businesses and residential buildings occupy the area along and south of Old Country Road.

The study area is served by municipal public water, sanitary and storm water sewer systems. The surrounding residential and commercial/industrial area is also served by public water and municipal sewer systems. Storm water flows from catch basins in the streets into a recharge basin located several miles south of the study area.

1.2.1 Summary of Previous On-site Investigations

The building at the site was constructed in 1949 with at least one expansion in 1957. The building has been occupied by a dry cleaner since at least 1957. The building was connected to the municipal sanitary sewer system in 1979 or 1980. Prior to this time, wastewater generated on-site was apparently discharged to an on-site sanitary system.

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123 POST AVE - OPERABLE UNIT 2
WESTBURY, NEW YORK

SITE LOCATION MAP

SCALE: 1"=1,000'

FIGURE 1-1

F:\3150-17C\dwg\3150-17C-Site Loc Map.dwg, 11X17, 9/10/2018 10:48:06 AM, kalesius

In December 1997, the NYSDEC issued a Notice of Intent to Designate a Potential Hazardous Waste Disposal Site for the site. In June 1998, the United States Environmental Protection Agency (USEPA) approved an Underground Injection Control (UIC) Closure Plan for the floor drains in the on-site building. In July 1998, it was revealed to the Nassau County Department of Health (NCDH) by the consultant for the property owner that soil samples had been collected from the two floor drains in January 1996. At that time, soil samples from the floor drain in the boiler room contained tetrachloroethene (PCE) at concentrations up to 18,000 micrograms per kilogram (ug/kg) and trichloroethene (TCE) at concentrations up to 100 ug/kg. Soil samples from the workroom floor drain contained PCE at concentrations up to 5,800,000 ug/kg and TCE at concentrations up to 40,000 ug/kg.

In August 1998, soils were excavated from beneath each of the floor drains. Endpoint samples achieving standards, criteria and guidance (SCGs) criteria were collected from the boiler room floor drain. Endpoint samples collected from the workroom floor drain contained PCE at concentrations up to 220,000 ug/kg. Since additional soil removal could not be conducted due to concerns about undermining the building foundation, soil vapor extraction (SVE) was recommended for remediation of the remaining soil contamination. Ten drums (7,000 pounds) of PCE-contaminated soil from the floor drains were transported for off-site disposal as hazardous waste in October 1998. Based on these results, the site was placed on the New York State Registry of Inactive Hazardous Waste Sites in December 1998.

In February 1999, the USEPA approved a source area investigation for the site to evaluate groundwater contamination from the floor drains. As part of this investigation, one monitoring well (MW-1) was constructed at the upgradient boundary of the site and two monitoring wells (MW-2 and MW-3) were constructed between the on-site building and the LIRR tracks in March 1999. PCE was detected in the upgradient well at a concentration of 95 micrograms per liter (ug/l) and in the downgradient wells at concentrations up to 20,000 ug/l. The USEPA response to the June 1999 report describing the groundwater sample results recommended additional on-site investigation but did not address the need for off-site investigation.

In March 1999, a soil boring was constructed through the workroom floor drain to evaluate the vertical distribution of the detected contamination. PCE was found in each sample collected. The maximum PCE concentration detected was 270,000 ug/kg at 10 to 11 feet below ground surface (bgs). PCE concentrations decreased with depth to the water table (53 ug/kg at 20 to 22 feet bgs and 17 ug/kg at 30 to 32 feet bgs) and increased slightly just below the water table (62 ug/kg at 36 to 40 feet bgs).

In August 2000, a revised work plan for additional investigation at the site was submitted to the NYSDEC. Activities to be conducted under this work plan included collection of soil/ sediment samples from the former on-site septic system, collection of groundwater samples, including vertical profiling, and performance of a pilot study for an on-site soil and groundwater remediation system utilizing air sparging and soil vapor extraction (SVE). As part of that investigation, four soil borings were constructed immediately east of the on-site building. These borings were reportedly located in the vicinity of the former sanitary system, although the source of the information regarding the system's location was not reported. Two or three soil samples from each boring were collected for laboratory analysis. According to the report, the samples with the highest headspace readings, or the samples immediately above the water table, were analyzed for PCE, TCE and 1,2-dichloroethene (1,2-DCE). These compounds were not detected in any of the soil samples.

Groundwater samples were collected from the three existing shallow (water table) monitoring wells on-site and three direct push vertical profile borings located between the southern wall of the dry cleaner building and the LIRR tracks. Three samples were collected from each vertical profile boring at the approximate water table (depth of 36 to 40 feet or 40 to 44 feet below ground surface), and at depths of 56 to 60 feet and 76 to 80 feet below ground surface. PCE was detected in each of the nine vertical profile groundwater samples at concentrations ranging from 4 ug/l to 3,700 ug/l. At each location, the PCE concentration was greatest in the shallowest sample and decreased significantly with depth. PCE concentrations were highest at the location along the middle of the building's southern wall and lower at the southeastern and southwestern corners of the building. TCE and 1,2-DCE were only detected in the deepest sample collected at the northwestern corner of the building, at concentrations of 4 ug/l and 8 ug/l, respectively.

PCE was also detected in each of the monitoring wells samples. The two wells located south (downgradient) of the building (MW-2 and MW-3) contained PCE at concentrations of 5,800 ug/l and 16,000 ug/l, respectively. These wells are both located in the western portion of the site between the dry cleaner building and the LIRR tracks. MW-1, located adjacent to the northeastern corner of the building, contained PCE at 1,200 ug/l. Neither TCE nor 1,2-DCE were detected in any of the monitoring well samples.

A 4-well soil vapor extraction (SVE) system was installed at the site as part of an interim remedial measure to address indoor air impacts in buildings to the north and northwest of the site. The SVE system began operating in May 2001 and operated until April 2006 when it was shut down due to issues with the building owner. In September 2010 the system was re-activated. Limited information on the status of the system is available from 2010 until 2018. In 2018, D&B installed a new electrical service to power the existing SVE system and re-activated the system. D&B also installed three soil vapor points in paved areas surrounding the on-site building and two sub-slab vapor points within the on-site building to allow for continued monitoring of the system.

1.2.2 Summary of Previous Off-site Investigations

During a property transfer investigation conducted at 117 Post Avenue, immediately south of the LIRR tracks that form the southern boundary of the site, seven monitoring wells were installed and elevated levels of PCE were detected in each of the seven wells.

In May 1998, TCE was detected in Westbury Water District Well No. 11 south of the site at a concentration of 1.0 ug/l. Since then, TCE has consistently been detected in Well No. 11 at levels below the New York State drinking water standard of 5 ug/l. Trace concentrations of 1,2-dichloroethene (1,2-DCE) also have been sporadically detected in Well No. 11. There is currently no treatment on Well No. 11 prior to distribution.

In October 2000, a groundwater sample was collected by the NCDH from the water supply well at a car wash located south of the site. PCE, chloroform and methyl tert-butyl ether were found at detectable levels. It should be noted that the car wash supply well was screened from 55 to 65 feet below ground surface in 2000. The well was subsequently reinstalled in February 2002 as a 200 foot well.

Periodic sampling of indoor air has been performed by the NCDH and NYSDEC at locations surrounding the site since 2000. PCE concentrations above the New York State Department of Health (NYSDOH) exposure limit for residential properties were detected in samples collected from the basement of the shopping center immediately north of the site and from an apartment on the first floor of the apartment building immediately west of the site. Since the impacted off-site properties are located outside the area of highly contaminated groundwater in the upgradient and side gradient directions, the detected PCE is likely attributable to migration through the unsaturated zone, rather than volatilization from the groundwater. Air filtration units were installed by the NCDH and NYSDEC in the basement of the adjacent shopping center and the impacted apartment for several months until PCE concentrations were less than the NYSDOH exposure limit. It is likely that operation of the on-site SVE system has reduced the migration of vapors to off-site buildings.

A passive venting system was incorporated into the design of the newly constructed assisted living facility at 117 Post Avenue, located immediately south of the LIRR tracks adjacent to the site. The system was constructed to prevent exposure of residents to vapors that may volatilize from groundwater and migrate into the building.

A Remedial Investigation was previously performed for the 123 Post Avenue – OU2 site in 2002. The results of the RI report indicated that the concentrations of total target VOCs (PCE, TCE and 1,2-DCE) in direct push and monitoring well samples ranged from non-detect to 11,294 ug/l. The greatest concentrations of target VOCs were detected nearest the site at the 117 Post Avenue property and immediately south on Madison Avenue. In addition, the depth of the zone most highly impacted by the target VOCs increased to the south-southwest. The plume was defined to be fairly narrow with approximate dimensions of 200 feet wide by at least 1,800 feet long. The plume was found to gradually sink within the Upper Glacial aquifer toward the south-southwest sinking at a rate of approximately 1 vertical foot per 10 horizontal feet. The thickness of the plume was defined at approximately 60 feet. It was also thought that the clay layer observed at approximately 115 feet below ground surface may mitigate the vertical migration of the plume.

Annual groundwater sampling was performed by NYSDEC in 2002 and 2003 which continued to identify concentrations of total target VOCs in groundwater monitoring wells south and downgradient of the site between 1 and 5 ppm.

A Feasibility Study and Record of Decision (ROD) were prepared for the site in 2004. The selected remedy for the site was in situ chemical oxidation of the contaminated groundwater plume (concentration of total target VOCs greater than 1 ppm) identified in the Upper Glacial aquifer downgradient of the site with provision for a remedial design to verify the components of the conceptual design; groundwater monitoring program; soil vapor intrusion evaluation; and, institutional controls in the form of groundwater use restrictions.

A remedial design for the implementation of the in situ chemical oxidation was initiated in early 2006. Consistent with the ROD, this work assignment included the performance of a pilot study for in-situ chemical oxidation to obtain necessary data for the full-scale remedial design. In addition, groundwater sampling of the existing wells and temporary Geoprobe points was performed to evaluate the change in groundwater contaminant concentrations since the last round of groundwater sampling performed in 2003. The highest total targeted VOC concentration was 1 ppm, with most concentrations less than 0.5 ppm. The highest concentrations were detected further downgradient from the site. Based on the results of the groundwater sampling, an in-situ chemical oxidation pilot study was proposed to be performed in the area of the highest groundwater contaminant concentrations from the 2006 sampling. Due to difficulties in obtaining funding for the pilot study, NYSDEC was not able to issue notification to proceed until the spring of 2008. Results of the pre-injection groundwater sampling from the pilot study wells indicated low levels of total target VOCs, indicating that the groundwater plume further migrated, and it was determined that the plume appeared to be migrating further downgradient from the site as well as to deeper depths. Further discussions with NYSDEC and NYSDOH lead to the request by NYSDEC for the performance of a chemical oxidation injection program in 2010.

The pilot study was performed between October 2011 and March 2013 in the vicinity of groundwater monitoring well OU2-3 between Lennox Avenue, Bedford Avenue, and along South Grand Street. A total of thirteen groundwater monitoring wells and three injection wells were installed at the site to perform the pilot study. Pre-injection groundwater sampling was performed in January 2012. Chemical oxidation injections were performed in September and October 2012. A total of approximately 25,000 gallons of sodium permanganate was injected into the aquifer. Post injection groundwater sampling was performed in December 2012 and February 2013. The findings of the injection and post injection sampling indicated that sodium permanganate reduced the concentrations of PCE and its breakdown products in groundwater. At 20 weeks after injection, sodium permanganate remained unreacted in the groundwater up to 27 feet from the injection points. No significant groundwater mounding nor significant injection pressures were noted during the injections. In addition, no volatile organic vapors were noted in nearby soil vapor probes during the injection.

Due to continued concerns regarding migration of the plume to greater depths and further downgradient, NYSDEC decided to re-open the remedial investigation phase of the project to further investigate the nature and extent of the groundwater plume. The results of this subsequent remedial investigation are presented below.

1.3 Remedial Investigation Results

The following is a summary of the findings and conclusions resulting from the remedial investigation and risk assessment conducted for the 123 Post Avenue site – OU2 as a function of the media investigation. These findings and conclusions are based on comparison of the investigation results to standards, criteria and guidelines (SCGs) selected for the site. The results of the investigation are described in detail in the Remedial Investigation Report, dated December

2018. It should be noted that after the Remedial Investigation was finalized, emerging contaminants became listed compounds in New York State. Results of the remedial investigation found that perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS) and 1,4-dioxane were detected above their respective MCL's. Therefore, the groundwater remediation technologies evaluated in this feasibility study include treatment for PFOA, PFOS and 1,4-dioxane.

Site Geology

Long Island is composed of a thick succession of unconsolidated sediments overlying a southeasterly sloping bedrock basement. In the region of Nassau County, the thickness of the unconsolidated deposits ranges from approximately 400 feet on the north shore of Long Island to greater than 1,500 feet on the south shore. The approximate thickness of the unconsolidated deposits in proximity of the site is estimated to be 700 feet. Within the study area, the Upper Glacial aquifer is approximately 100 to 150 feet thick and consists of glacial outwash which is generally fine to coarse sand and gravel. Hydraulic conductivity values average 250 ft/day. The Magothy aquifer ranges from 300 to 600 feet thick. The unit consists mostly of fine to medium sand to clayey sand interbedded with lenses and layers of coarse sand, and sandy to solid clay. Gravel is common in the basal zone and discontinuous layers of gray lignitic clay are common in the upper zones. Hydraulic conductivities average 50 to 60 ft/day and may range as high as 190 ft/day in the basal zone.

Unconsolidated deposits within the study area generally consist of fine to coarse sand with varying amounts of silt and gravel. The primary unit observed during the initial Remedial Investigation field activities was fine-to-medium grained sand. Soil conductivity logs from the initial Remedial Investigation show that the upper 80 feet of glacial sediments at these locations consist of sand with little variation. The gamma logs for well bore holes OU2-2 through OU2-5 and boring logs from the permanent monitoring wells installed OU2-1 through OU2-5 also show that the stratigraphy is mostly sand to approximately 115 feet below ground surface. Boring logs for monitoring wells OU2-12 D/E and OU2-13 D/E also show that the upper 100 feet of glacial sediments consist primarily of sand with little silt and gravel. This is also supported by the gamma log for monitoring well OU2-13 D/E.

A clay layer was identified below the glacial sediments in the study area north of Old Country Road. The clay layer was encountered at approximately 115 feet below ground surface in the borings for wells OU2-3 and OU2-4, located approximately 1,200 and 1,700 feet south-southwest of the site, respectively. Clay was not identified in the boring for well OU2-5 to a depth of 130 feet below ground surface. During construction of monitoring well OU2-12 D/E a 7-foot-thick clay layer was encountered at 123 feet below ground surface. From 130 feet to the completion depth of the borehole at 350 feet, multiple clay layers were encountered with various thicknesses. Thinner clay layers were encountered during construction of OU2-13 D/E and with less consistency. The information provided in the boring log for this borehole is supported by the gamma log for this boring which also show fewer, thinner clay layers in this borehole than those encountered during construction of OU2-12 D/E. Similarly, the boring log for OU2-18D from 286 to 316 feet below ground surface does not indicate the presence of any significant clay layers.

With regard to water supply wells, the driller's log for the car wash supply well shows fine-to-medium sand to 65 feet below ground surface and a gray clay from 66 to 160 feet below ground surface and medium to fine sand from 160 to 200 feet below ground surface. The log for Westbury Water District Well No. 11 shows a unit consisting of sand, brown clay and iron oxide from 82 to 136 feet below ground surface, and clay layers, ranging from 4 to 31 feet thick, between depths of 136 and 473 feet below ground surface. The driller's log for the Well No. N-9709 (Deep East Well) at the Covanta facility shows coarse brown sand and gravel from ground surface to 45 feet and solid brown clay from 45 to 52 feet below ground surface. From 52 feet below ground surface to well completion depth of 365 feet, several clay layers were encountered within fine to medium brown sand with thicknesses ranging between 5 to 24 feet in thickness. The driller's log for Well No. N-10975 (Shallow Supply Well) at the Covanta facility also showed fine to medium sand with intermittent layers of clay at various thicknesses.

These logs indicate that the clay layers are not continuous in the study area. As such, the clay layers may impede, but not prevent, vertical migration of contaminants.

Site Hydrogeology

The water table during the latest round of groundwater sampling conducted between December 2017 and February 2018 was encountered in the study area at depths ranging from 37.94 to 46.10 feet below ground. The groundwater elevations measured during this round of groundwater sampling were 62.91 feet in the northernmost well OU2-1 and 51.2 feet in the southernmost well OU2-VPB2, indicating a south-southwesterly direction of groundwater flow. Since the permanent well locations were selected based primarily on the vertical profile boring groundwater sample results, the wells were installed in a nearly linear configuration at varying depths within the Magothy Aquifer. As a result, a groundwater elevation contour map could not be prepared. However, based on the VOC detections from the groundwater sample results which define a narrow contaminant plume, the groundwater flow direction within the study area is toward the south-southwest.

Recent Groundwater Sampling Results

In March and April of 2017, twelve existing and newly installed monitoring wells (OU2-11, OU2-12D, OU2-12E, OU2-13D, OU2-13E, OU2-14C, OU2-14D, OU2-15C, OU2-15D, OU2-17C, OU2-17D and OU2-18D), the car wash well and two commercial water wells (east deep and west deep) were sampled. In July of 2017, OU2-19-VPB1, OU2-19-VPB2, OU2-19-VPB3 and OU2-19-VPB4 were sampled in order to determine if there was consistency between the vertical profile boring groundwater sample analytical results and the newly installed monitoring wells groundwater sample analytical results. Once all the wells were installed, a final round of groundwater sampling was performed between December 2017 and February 2018. The sample location map is provided on Figure 1-2. During this latest round of groundwater sampling the following wells were sampled: OU2-1, OU2-2, OU2-3/IW-2, OU2-4, OU2-5, OU2-6, OU2-7A, OU2-7B, OU2-8A, OU2-8B, OU2-8C, OU2-9A, OU2-9B, OU2-9C, OU2-10A, OU2-10B, OU2-10C, OU2-11, OU2-12D, OU2-12E, OU2-13D, OU2-13E, OU2-14C, OU2-14D, OU2-15C, OU2-15D, OU2-17C, OU2-17D, OU2-17-VPB2, OU2-18D, OU2-18-VPB2,

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123 POST AVENUE - OPERABLE UNIT 2
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SCALE: 1"=300'

SAMPLE LOCATION MAP

FIGURE 1-2

OU2-19-VPB1, OU2-19-VPB2, OU2-19-VPB3, OU2-19-VPB4, OU2-19-VPB5, OU2-20-VPB1, OU2-21-VPB1, OU2-21-VPB2, OU2-21-VPB3, OU2-IW-1, OU2-IW-3, OU2-IW-4, PSW-4D, PSW-4S and the car wash well.

Groundwater samples were also analyzed for emerging contaminants during the recent groundwater sampling events during the RI. OU2-11, OU2-12D, OU2-12E, OU2-13D, OU2-13E, OU2-14C, OU2-14D, OU2-15C, OU2-15D, OU2-17C, OU2-17D, OU2-18D, the car wash well and two commercial water wells (east deep and west deep) were sampled for per- and poly-fluoroalkyl substances (PFAS) and 1,4-dioxane in March and May 2017. Additionally, OU2-19-VPB4, OU2-19-VPB5, OU2-20-VPB1, OU21-VPB1 and OU2-21-VPB3 were sampled for PFAS and 1,4-dioxane in January and February 2018. As previously discussed, these emerging contaminants became listed compounds in New York State after the Remedial Investigation was finalized. Accordingly, perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS) and 1,4-dioxane were detected above their respective MCL's.

Based on previous investigations conducted at the 123 Post Avenue site and the groundwater sampling results from the RI, three chlorinated compounds typically associated with dry cleaner sites, PCE, TCE and 1,2-DCE, have been identified as contaminants of concern. PCE is used as a dry-cleaning solvent, and TCE and 1,2-DCE are breakdown products of PCE.

Although the primary VOCs detected were PCE, TCE, and 1,2-DCE, several other VOCs were detected at concentrations exceeding their respective Class GA groundwater standard or guidance value throughout the various sampling programs. For the purposes of this feasibility study, the only VOCs that will be discussed will be PCE, TCE and 1,2-DCE. Additionally, the groundwater remediation technologies that are being evaluated will include treatment for PFOA, PFOS and 1,4-dioxane, which are comingled with the PCE plume. These emerging contaminants became listed compounds in New York State after the remedial investigation for Site was finalized.

The approximate horizontal extent of total targeted VOCs detected in monitoring wells within the study area is shown on Figures 1-3, 1-4 and 1-5 for PCE, TCE, and 1,2-DCE, respectively. The data presented in these figures include the most recent sampling event, conducted from December 2017 through February 2018. For each monitoring well, the maximum concentration of total target VOCs is shown. The chlorinated VOC plume is depicted by total target VOC contours of 5 ug/l, 50 ug/l and 500 ug/l and extends from the area south of the 123 Post Avenue site in a south-southwest direction. The PCE plume is fairly narrow (as delineated by 5 ug/l contour), with approximate dimensions of approximately 2,200 feet wide by approximately 7,200 feet long (extending south of Stewart Avenue). The 1,2-DCE plume has a similar configuration as the PCE plume with smaller areas of concentrations greater than 50 and 500 ug/l and the center of mass shifted easterly indicating that there may be another source of 1,2-DCE contamination in groundwater. The configuration of the TCE plume is much different than the PCE plume and the 1,2-DCE plume, however; the variation in the width of the plume, particularly in the area of Corporate Drive seems to indicate that there may be another source of TCE contamination in groundwater. This is supported by the fact that the highest concentrations of TCE were detected in the vertical profile borings and monitoring wells that are 600 to 900 feet east of the vertical profile borings and wells with highest concentrations of PCE. This contamination identified to the east of the PCE plume is being further evaluated through a Site Characterization implemented by the NYSDEC under its Superfund Program.

NOTES

1. ALL CONCENTRATIONS SHOWN ARE IN MICROGRAMS PER LITER (ug/l)
2. TOWN OF HEMPSTEAD MONITORING WELL ANALYTICAL DATA (WELL NOS. N-9709, N-9751 AND N-10975) OBTAINED FROM MAY 22, 2017 SAMPLING EVENT.
3. ROOSEVELT FIELD MONITORING WELL ANALYTICAL DATA (WELL NOS. N-7957 AND N-9846) OBTAINED FROM MAY 2015 SAMPLING EVENT.

*: CONCENTRATION DETECTED IN VERTICAL PROFILE BORING OU2-V18-VPB2 COMPLETED AT MONITORING WELL LOCATION AT A DEPTH OF 250 FEET BELOW GRADE.

LEGEND

⌖	MONITORING WELL LOCATION AND DESIGNATION
⌖	WATER SUPPLY WELL AND DESIGNATION
OU2-3/IW-2 (88.2)	WELL DESIGNATION WITH PCE CONCENTRATION IN PARENTHESIS
—5—	APPROXIMATE PCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED.
ND	NOT DETECTED
NS	NOT SAMPLED

0 300'
SCALE: 1"=300'

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SCALE: 1"=300'

MONITORING WELL SAMPLE RESULTS - PCE ISOCONTOURS
DECEMBER 2017 - FEBRUARY 2018

FIGURE 1-3

F:\3150-17C\dwg\3150-17C-GROUNDWATER SAMPLE RESULTS - PCE FIGURE 2.dwg, FIG 1 DEC17-FEB18, 9/12/2018 11:26:55 AM, rwysocki

LEGEND

- MONITORING WELL LOCATION AND DESIGNATION
- WATER SUPPLY WELL AND DESIGNATION
- OU2-3/IW-2 (1.65) WELL DESIGNATION WITH TCE CONCENTRATION IN PARENTHESIS
- 5 APPROXIMATE TCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED.
- ND NOT DETECTED
- NS NOT SAMPLED

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0 300'
SCALE: 1"=300'

F:\3150-17C\dwg\3150-17C-GROUNDWATER SAMPLE RESULTS - TCE FIGURE 3.dwg, FIG 3 DEC17-FEB18, 9/12/2018 11:54:38 AM, rwysocki

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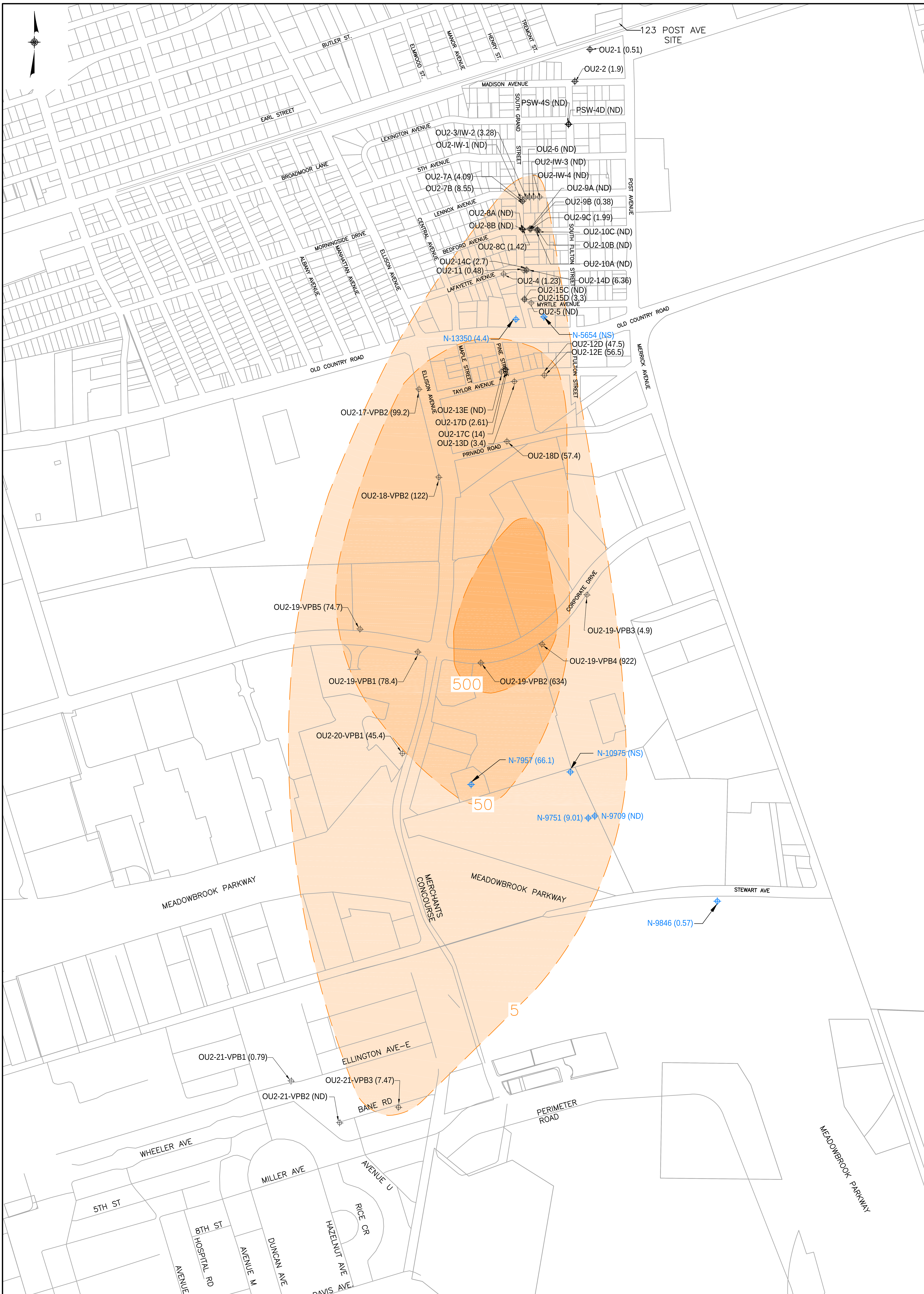
123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

SCALE: 1"=300'

GROUNDWATER SAMPLE RESULTS - TCE ISOCONTOURS
DECEMBER 2017 - FEBRUARY 2018

FIGURE 1-4



LEGEND

- MONITORING WELL LOCATION AND DESIGNATION
- WATER SUPPLY WELL AND DESIGNATION
- OU2-3/IW-2 (3.28) — WELL DESIGNATION WITH DCE CONCENTRATION IN PARENTHESIS
- —5— APPROXIMATE DCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED.
- ND — NOT DETECTED
- NS — NOT SAMPLED

NOTES

1. ALL CONCENTRATIONS SHOWN ARE IN MICROGRAMS PER LITER (ug/l)
2. TOWN OF HEMPSTEAD MONITORING WELL ANALYTICAL DATA (WELL NOS. N-9709, N-9751 AND N-10975) OBTAINED FROM MAY 22, 2017 SAMPLING EVENT.
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0 300'
SCALE: 1"=300'

F:\3150-17C\dwg\3150-17C-GROUNDWATER SAMPLE RESULTS - DCE FIGURE 4.dwg, FIG 4 DEC17-FEB18, 9/12/2018 11:27:17 AM, rwysocki

D&B ENGINEERS AND ARCHITECTS, P.C.

123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

SCALE: 1"=300'

GROUNDWATER SAMPLE RESULTS - CIS-1,2-DCE ISOCONTOURS
DECEMBER 2017 - FEBRUARY 2018

FIGURE 1-5

The vertical distribution of contaminants is depicted in cross sections shown on Figure 1-6. A north-south cross-section is oriented along the center axis of the identified PCE plume parallel to groundwater flow. This cross section, as shown on Figure 1-7, indicates that the plume emanates from the vicinity south of the 123 Post Avenue site and gradually sinks within the aquifer toward the south-southwest. The maximum thickness of the plume (PCE greater than 5 ug/l) is approximately 250 feet. The thickness of the more concentrated plume (PCE greater than 500 ug/l) is approximately 75 to 80 feet.

A west-east cross-section of the plume was created along Corporate Drive. Estimated vertical extent of PCE, TCE and 1,2-DCE are shown in Figures 1-8, 1-9, and 1-10, respectively. As shown by the figures, the highest concentrations of PCE are in the area surrounding OU2-19-VPB1 and the highest concentrations of TCE and 1,2-DCE are further to the east with the highest concentrations of TCE in the area of OU2-19-VPB3 and OU2-19-VPB4, and the highest concentrations of 1,2-DCE in the area of OU2-19-VPB2 and OU2-19-VPB4. As discussed above, the difference in the plume configurations are likely attributable to a secondary source of TCE and 1,2-DCE contributing to and/or comingling with the PCE plume emanating from the 123 Post Avenue site.

The three commercial wells in the vicinity of the site were sampled during the Remedial Investigation field activities. The car wash well (N-13350) was sampled three times and two commercial water wells on the Covanta property (East Deep (N-9709) and West Deep (N-9751)) were each sampled once during this remedial investigation. The results of the analysis of the samples collected from the car wash well indicated the presence of PCE at a concentration of 610 ug/l in 2014. Sample results from the 2017 and 2018 sampling events indicated the presence of PCE at concentrations of 210 ug/l and 220 ug/l, respectively. TCE and 1,2 DCE were detected in the 2014 sample above their respective Class GA groundwater standard at 13 ug/l and 6.9 ug/l, respectively. TCE and 1,2- DCE were not detected at levels above Class GA groundwater

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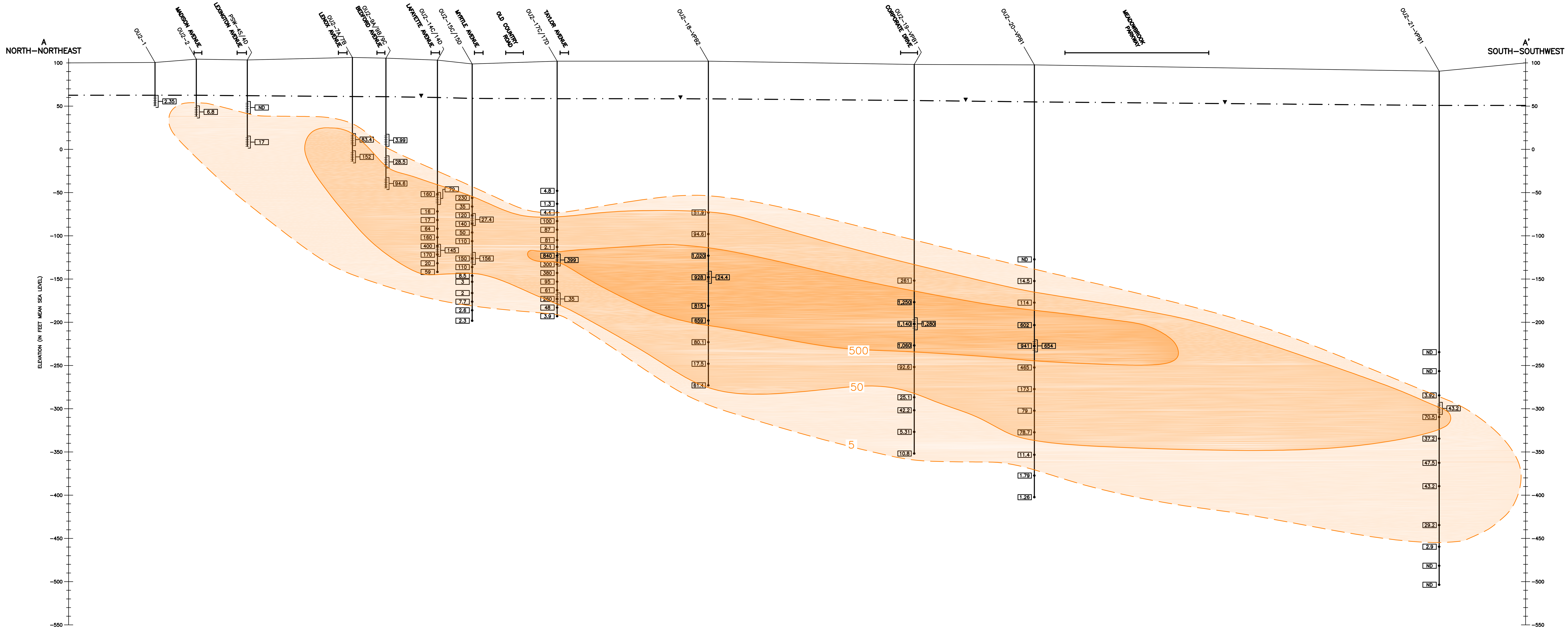
123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

CROSS-SECTION LOCATION MAP

SCALE: 1"=300'

FIGURE 1-6



LEGEND

WATER TABLE ELEVATION

APPROXIMATE PCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED

WELL SCREEN

VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLE LOCATION

19.7 TOTAL CONCENTRATION OF PCE (UG/L)

ND NOT DETECTED

PCE TETRACHLOROETHENE

NOTES:

1. GROUNDWATER MONITORING WELL SAMPLES WERE COLLECTED BETWEEN DECEMBER 2017 AND FEBRUARY 2018.
2. VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLES WERE COLLECTED BETWEEN DECEMBER 2015 AND NOVEMBER 2017.

0 300' 600'

0 60' 120'

HORIZONTAL SCALE: 1"=300'
VERTICAL SCALE: 1"=60'

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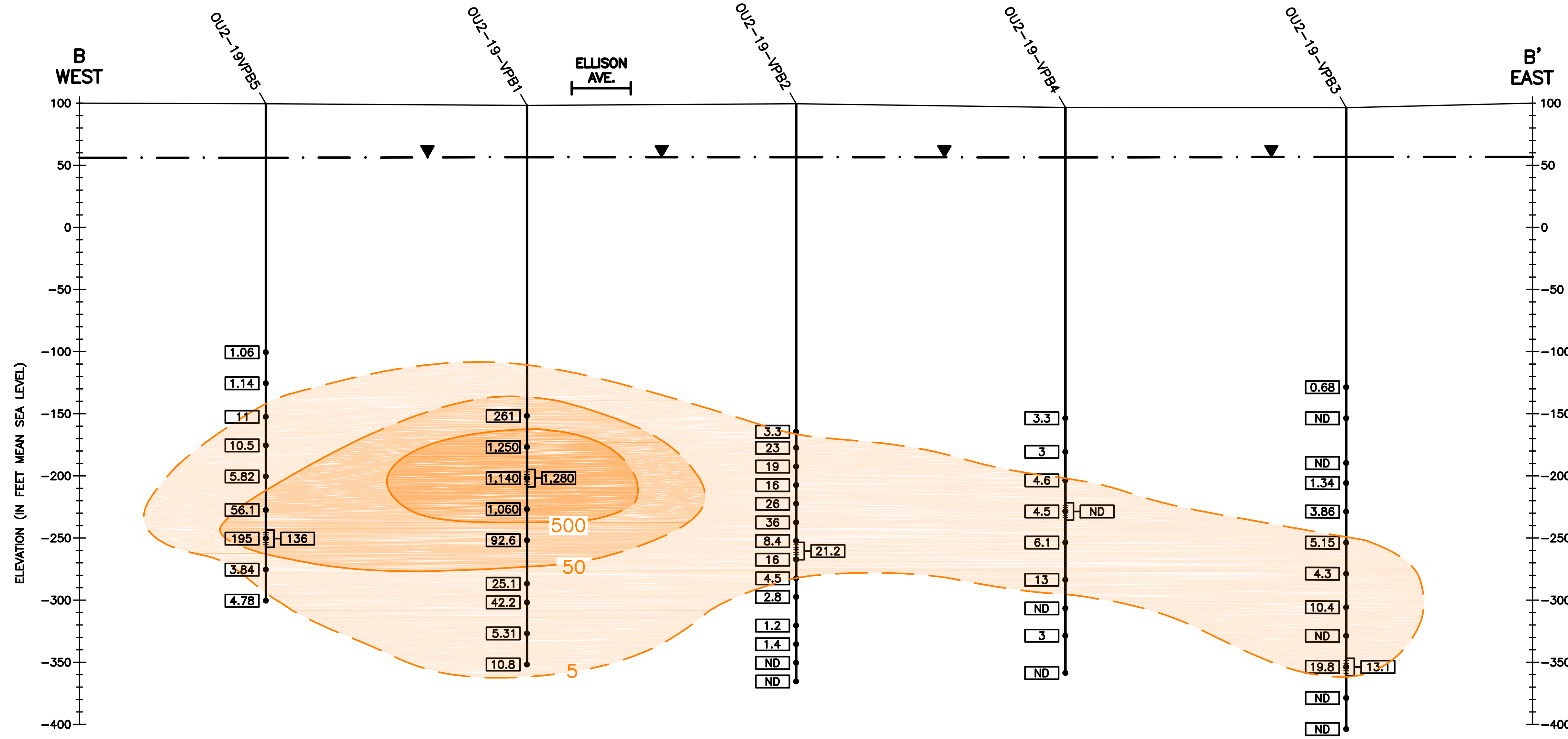
123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

ESTIMATED VERTICAL EXTENT OF PCE PLUME (NORTH/NORTHWEST - SOUTH/SOUTHWEST)

FIGURE 1-7



LEGEND

WATER TABLE ELEVATION

5 APPROXIMATE PCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED

WELL SCREEN

VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLE LOCATION

261 TOTAL CONCENTRATION OF PCE (UG/L)

PCE TETRACHLOROETHYLENE

ND NOT DETECTED

NOTES:

1. GROUNDWATER MONITORING WELL SAMPLES WERE COLLECTED BETWEEN DECEMBER 2017 AND FEBRUARY 2018.

2. VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLES WERE COLLECTED BETWEEN APRIL AND JUNE 2017.

0 200' 400'

0 100' 200'

HORIZONTAL SCALE: 1"=200'
VERTICAL SCALE: 1"=100'

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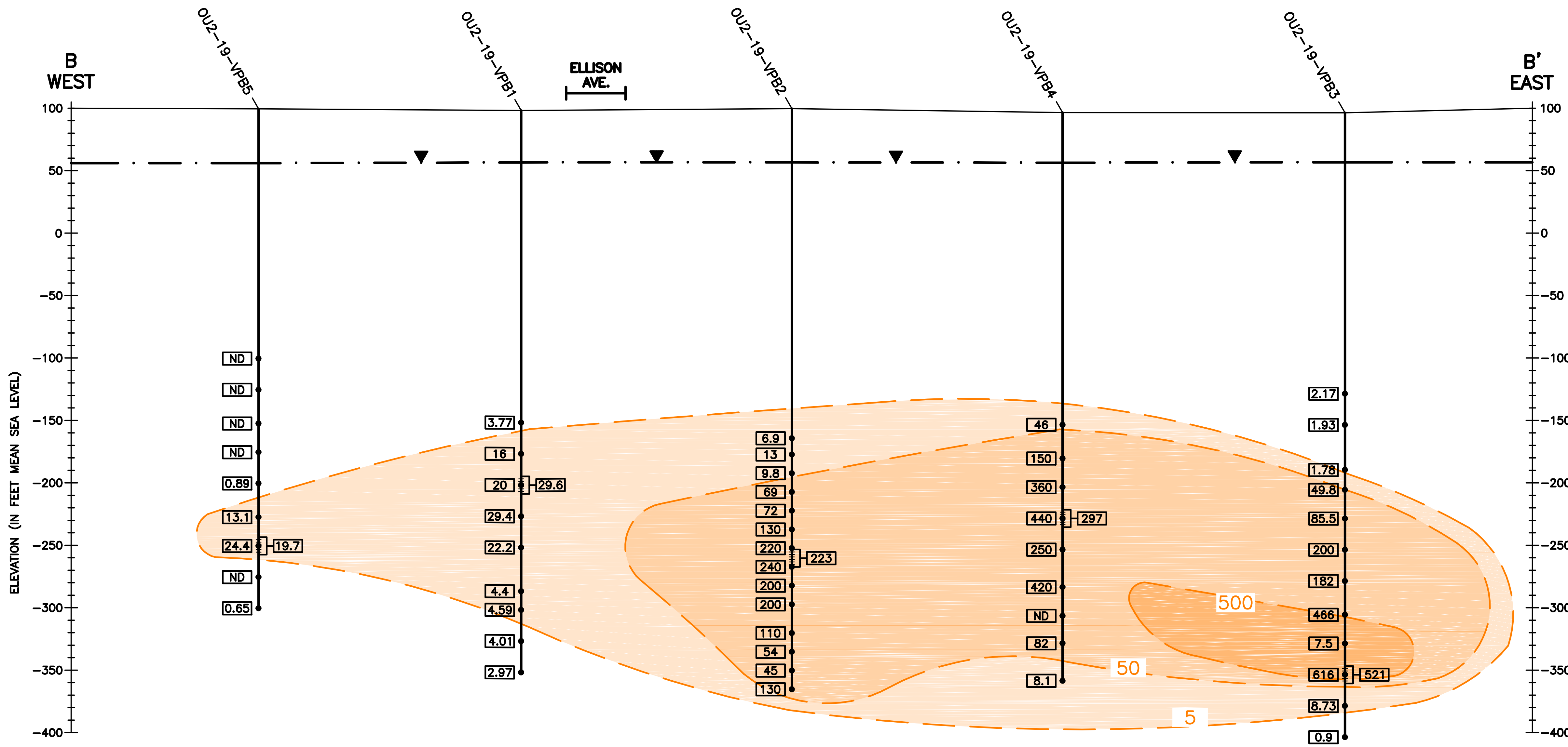
123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

ESTIMATED VERTICAL EXTENT OF PCE PLUME (WEST - EAST)

FIGURE 1-8



LEGEND

WATER TABLE ELEVATION

5 — APPROXIMATE TCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED

WELL SCREEN

VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLE LOCATION

261 — TOTAL CONCENTRATION OF TCE (UG/L)

TCE — TRICHLOROETHENE

ND — NOT DETECTED

NOTES:

1. GROUNDWATER MONITORING WELL SAMPLES WERE COLLECTED BETWEEN DECEMBER 2017 AND FEBRUARY 2018.
2. VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLES WERE COLLECTED BETWEEN APRIL AND JUNE 2017.

0 200' 400'

0 100' 200'

HORIZONTAL SCALE: 1"=200'
VERTICAL SCALE: 1"=100'

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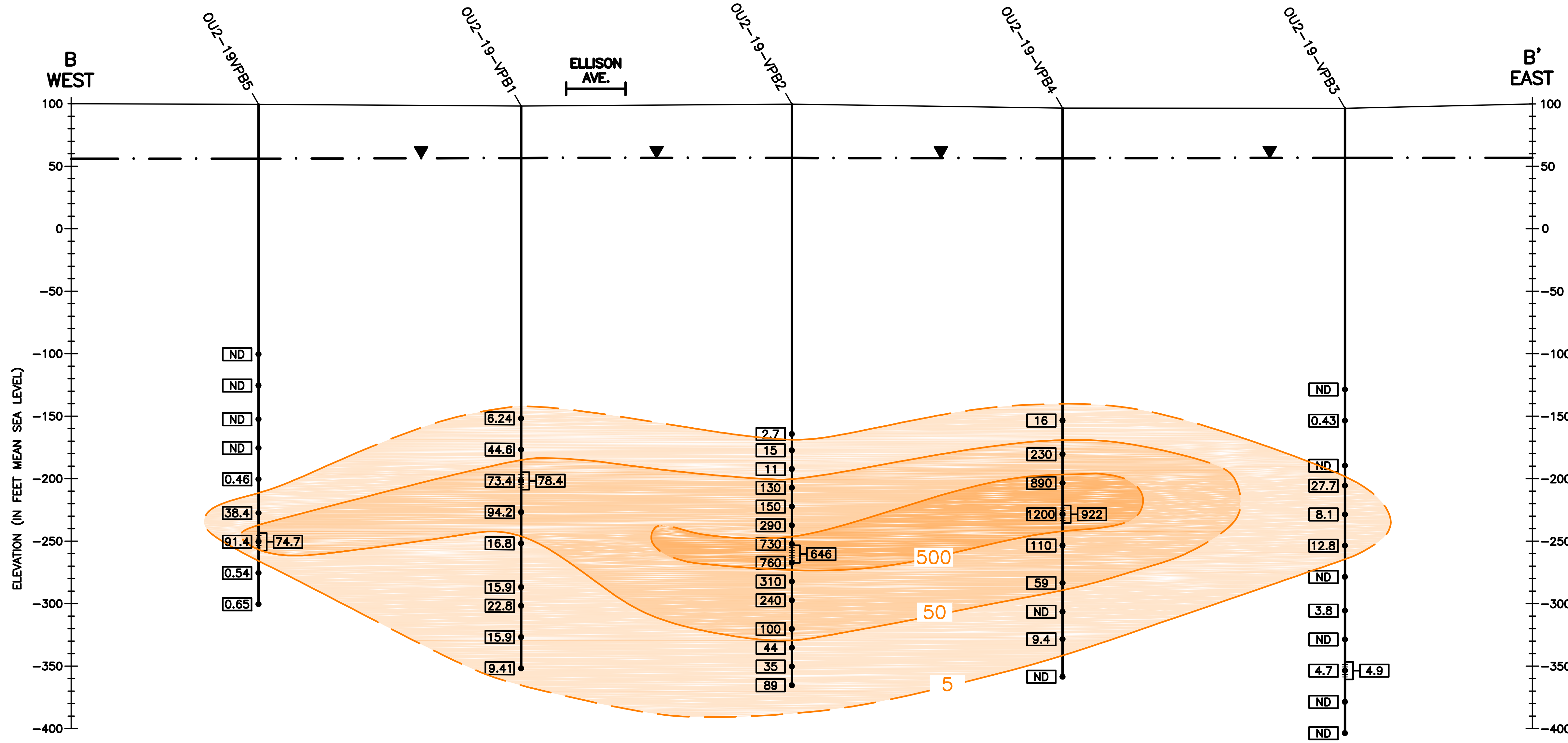
123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

ESTIMATED VERTICAL EXTENT OF TCE PLUME (WEST - EAST)

FIGURE 1-9

F:\3150-17C\dwg\3150-17C-TCE PLUME.dwg, Cross section, 9/12/2018 11:28:13 AM, rwysocki



LEGEND

WATER TABLE ELEVATION

5 — APPROXIMATE CIS-1,2-DCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED

WELL SCREEN

VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLE LOCATION

6.24 TOTAL CONCENTRATION OF CIS-1,2-DCE (UG/L)

CIS-1,2-DCE CIS-1,2-DICHLOROETHENE

ND NOT DETECTED

NOTES:

1. GROUNDWATER MONITORING WELL SAMPLES WERE COLLECTED BETWEEN DECEMBER 2017 AND FEBRUARY 2018.
2. VERTICAL PROFILE BORING DISCRETE GROUNDWATER SAMPLES WERE COLLECTED BETWEEN APRIL AND JUNE 2017.

0 200' 400'

0 100' 200'

HORIZONTAL SCALE: 1"=200'
VERTICAL SCALE: 1"=100'

F:\3150-17C\dwg\3150-17C-DICHLOROETHENE PLUME.dwg, Cross section, 9/12/2018 11:28:47 AM, rwysocki

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123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

ESTIMATED VERTICAL EXTENT OF CIS-1,2-DCE PLUME (WEST - EAST)

FIGURE 1-10

standards in the 2017 and 2018 sampling event. The sampling of the East Deep and West Deep wells in 2017 indicated the presence of PCE above Class GA groundwater standards at 15.2 ug/l within the East Deep well and PCE was not detected within the sample collected from the West Deep well. TCE was detected above its groundwater standard in the East Deep at 265 ug/l and below standards in the West Deep well at 0.77 ug/l. Note that the screened zone for the East Deep well is 305 to 363 feet below ground surface and the screened zone for the West Deep well is 125 to 283 feet below ground surface.

1.4 Exposure Assessment Results

The human health exposure assessment evaluated the potential human health exposures to the chemical contamination detected in groundwater downgradient of the 123 Post Avenue site. Potential exposures were evaluated on the basis of the environmental setting of the study area, and information on the nature and extent of contamination as described in the RI report. Relevant environmental information is discussed in the context of current and potential human contact with contaminants of concern at potential locations where human exposure could occur without any remedial measures implemented to mitigate exposure to contaminants. The human health exposure assessment is included in the Remedial Investigation Report.

Based on the results of the human health exposure assessment, the complete pathways identified for human exposure associated with the groundwater contamination detected during the RI include employees and patrons of the Big M Car Wash of Westbury, as well as employees and patrons of nearby businesses of the Covanta facility. All of the complete pathways include inhalation exposure due to volatilization of contaminants from groundwater during car washing and cooling activities as well as dermal exposure to car wash employees from impacted groundwater utilized for car washing.

An additional potential pathway for exposure to impacted groundwater could be completed if a water supply well is constructed within the plume area in the future, if existing wells without treatment begin to be impacted by the plume, or if existing wells with treatment become impacted by contaminants at concentrations in excess of current treatment system capabilities. Any new potable wells constructed in within the plume would require treatment prior to distribution and any existing wells impacted by the plume in the future would also require treatment prior to distribution. While existing wells do not appear to be currently impacted by this plume, a public water supply protection plan for N-5654 (Westbury Well 11) will be evaluated as part of the feasibility study. This well is located approximately 2,000 feet south-southwest and downgradient from the site and is screened from 474 to 538 feet below grade surface. This well is not currently impacted by the plume; however, since it is not treated prior to distribution and contamination from the plume could potentially be captured by the supply well in the future a public water supply protection plan will be evaluated.

1.5 Remedial Action Objectives

Remedial action objectives are goals developed for the protection of human health and the environment. Definition of these objectives requires an assessment of the contaminants and media of concern, migration pathways, exposure routes and potential receptors. Typically, remediation goals are established based on standards, criteria and guidelines to protect human health and the environment. SCGs for the 123 Post Avenue site, which were developed as part of the remedial investigation, include NYSDEC Technical and Operational Guidance Series (TOGS) (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (1998). Based on these SCGs and the results of the RI, the remedial action objectives developed for OU2 are the following:

1. Protection of human health and the environment; and
2. Reduction of contaminant levels in groundwater to NYSDEC Class GA Standards to the extent practicable to prevent further migration of contaminated groundwater.

In addition to consideration of SCGs to meet the remedial action objectives, Applicable or Relevant and Appropriate Requirements (ARARs) are to be considered when formulating, screening and evaluating remedial alternatives, and selecting a remedial action. ARARs may be categorized as contaminant-specific, location-specific or action-specific. Federal statutes, regulations and programs may apply to the site where state or local standards do not exist.

Potentially applicable contaminant-specific, location-specific and action-specific ARARs for the 123 Post Avenue site, along with guidance, advisories, criteria, memoranda and other information issued by regulatory agencies to be considered (TBC), are presented in Tables 1-1, 1-2 and 1-3. As a note, many of the NYSDEC ARARs include federal requirements which have been delegated to New York State. Generally, federal ARARs are referenced when State requirements do not exist.

Table 1-1

POTENTIALLY APPLICABLE CHEMICAL SPECIFIC ARARs/TBCs
123 POST AVENUE SITE - OPERABLE UNIT 2

Citation/ Reference	Title	Applicable Media	Potential ARAR/TBC	Regulatory Agency
6 NYCRR 212	General Process Emission Sources	Air	ARAR	NYSDEC
6 NYCRR 257	Air Quality Standards	Air	ARAR	NYSDEC
6 NYCRR 371	Identification and Listing of Hazardous Waste	Hazardous Waste	ARAR	NYSDEC
6 NYCRR Part 375	Environmental Remediation Programs	Hazardous Waste	ARAR	NYSDEC
6 NYCRR 376	Land Disposal Restrictions	Hazardous Waste	ARAR	NYSDEC
6 NYCRR 700-705	Surface Water and Groundwater Classifications and Standards	Groundwater	ARAR	NYSDEC
State Sanitary Code - Part 5	Drinking Water Supply	Water Supply	ARAR	NYSDOH
TOGS 1.1.1	Ambient Water Quality Standards and Guidance Values	Groundwater	TBC	NYSDEC
DAR-1	Guideline for the Control of Toxic Ambient Air Contaminants	Air	TBC	NYSDEC
CP-51	Soil Cleanup Guidance	Soil	ARAR	NYSDEC

Table 1-2

POTENTIALLY APPLICABLE LOCATION SPECIFIC ARARs/TBCs
123 POST AVENUE SITE - OPERABLE UNIT 2

Citation/ Reference	Title	Applicable Media	Potential ARAR/TBC	Regulatory Agency
6 NYCRR 256	Air Quality Classification System	Air	ARAR	NYSDEC
N/A	Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites	Hazardous Waste Sites	TBC	NYSDEC
6 NYCRR Part 597	Hazardous Substances Identification, Release Prohibition, and Release Reporting	Hazardous Waste Sites	ARAR	NYSDEC

Table 1-3

POTENTIALLY APPLICABLE ACTION SPECIFIC ARARs/TBCs
123 POST AVENUE SITE - OPERABLE UNIT 2

Citation/ Reference	Title	Applicable Media	Potential ARAR/TBC	Regulatory Agency
6 NYCRR 200	General Provision	Air	ARAR	NYSDEC
6 NYCRR 201	Permits and Registrations	Air	ARAR	NYSDEC
6 NYCRR 211	General Prohibitions	Air	ARAR	NYSDEC
6 NYCRR 212	General Process Emission Sources	Air	ARAR	NYSDEC
6 NYCRR 364	Waste Transporter Permits	Solid/Hazardous Waste	ARAR	NYSDEC
6 NYCRR 370	Hazardous Waste Management System – General	Hazardous Waste	ARAR	NYSDEC
6 NYCRR 372	Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities	Hazardous Waste	ARAR	NYSDEC
6 NYCRR 373	Hazardous Waste Management Facilities	Hazardous Waste	ARAR	NYSDEC
6 NYCRR 375	Environmental Remediation Programs	Hazardous Waste	ARAR	NYSDEC
6 NYCRR 376	Land Disposal Restrictions	Hazardous Waste	ARAR	NYSDEC
6 NYCRR 617 and 618	State Environmental Quality Review	All Media	ARAR	NYSDEC
6 NYCRR 621	Uniform Procedures	All Media	ARAR	NYSDEC
6 NYCRR 624	Permit Hearing Procedures	All Media	ARAR	NYSDEC
6 NYCRR 650	Qualifications of Operators of Wastewater Treatment Plants	NA	ARAR	NYSDEC
6 NYCRR 700-705	Classifications and Standards of Quality and Purity	Groundwater	ARAR	NYSDEC
6 NYCRR 750	State Pollutant Discharge Elimination System (SPDES) Permits	Groundwater	ARAR	NYSDEC
DAR- 1	Guideline for the Control of Toxic Ambient Air Contaminants	Air	TBC	NYSDEC

Table 1-3 (continued)

POTENTIALLY APPLICABLE ACTION SPECIFIC ARARs/TBCs
123 POST AVENUE SITE - OPERABLE UNIT 2

Citation/ Reference	Title	Applicable Media	Potential ARAR/TBC	Regulatory Agency
N/A	Analytical Services Protocol	All Media	TBC	NYSDEC
TOGS 2.1.2	UIR at Groundwater Remediation Sites	Groundwater	TBC	NYSDEC
TOGS 2.1.3	Primary & Principal Aquifer Determinations	Groundwater	TBC	NYSDEC
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response	NA	ARAR	USDOL

1.6 Feasibility Study Description

This FS report was prepared in general conformance Section 4 of DER-10 (NYSDEC Division of Environmental Remediation [DER]), May 3, 2010). The feasibility study is prepared to identify and screen potentially applicable remedial technologies, combine technologies into alternatives and evaluate appropriate alternatives in detail, and select an appropriate remedial action plan. The objective of this feasibility study is to meet the goal of this guidance document, as well as applicable USEPA guidance in a focused, concise manner.

The approach of a feasibility study is to initially develop remedial action objectives for medium-specific or operable unit-specific goals to protect human health and the environment. The goals consider the contaminants and contaminant concentrations as determined by the remedial investigation, the exposure routes and potential receptors as determined by the human health exposure assessment, and the acceptable contaminant or risk levels or range of levels.

In the initial phase of the feasibility study, identified remedial technologies which are not technically applicable to contamination found, or are unproven and/or are not commercially available, will be eliminated from further consideration. The technologies remaining after initial screening will be assembled into remedial alternatives for evaluation. Preliminary evaluation of alternatives will consider effectiveness, implementability and relative costs.

Effectiveness evaluation includes consideration of the following:

- The potential effectiveness of process options in handling the estimated areas or volumes of contaminated media, and meeting the remediation goals identified by the remedial action objectives;
- The potential impacts to human health and the environment during the construction and implementation phase; and
- The proven effectiveness and reliability of the process with respect to the contaminants and conditions at the Site.

Implementability includes both the technical and administrative feasibility of utilizing the technology or alternative. Administrative feasibility considers institutional factors, such as the ability to obtain necessary permits for on-site or off-site actions, and the ability to restrict land use based on specific remediation measures. Technical feasibility considers such aspects as the ability to comply with SCGs, availability and capacity of treatment, storage and disposal facilities, the availability of equipment and skilled labor to implement the technology, the ability to design, construct and operate the alternative, and acceptability to the regulatory agencies and the public.

Preliminary costs are considered at this stage of the feasibility study process for the purpose of relative cost comparison among the alternatives.

The results of the preliminary evaluation include potentially viable technologies or combinations of technologies/alternatives for the site which will be carried forward for detailed evaluation.

The guidance requires that a feasibility study provide a detailed analysis of the potential remedial alternatives based on consideration of the following evaluation criteria for each alternative.

- Threshold Criteria
  - Compliance with standards, criteria and guidelines/ARARs
  - Protection of human health and the environment
- Balancing Criteria
  - Short-term impacts and effectiveness
  - Long-term effectiveness and permanence
  - Reduction in toxicity, mobility and/or volume of contamination
  - Implementability
  - Cost

Provided below is a description of each of the feasibility study criteria.

Compliance with applicable regulatory standards, criteria and guidelines applies the federal and New York State ARARs/SCGs identified for the 123 Post Avenue Site to provide both action-specific guidelines for remedial work at the site and contaminant-specific cleanup standards for the alternatives under evaluation. In addition to action-specific and contaminant-specific guidelines, there are also location-specific guidelines that pertain to such issues as restrictions on actions at historic sites.

Protection of human health and the environment is evaluated on the basis of estimated reductions in both human and environmental exposure to contaminants for each remedial action alternative. The evaluation focuses on whether a specific alternative achieves adequate protection, and how site risks are eliminated, reduced or controlled through treatment, engineering or institutional controls. An integral part of this evaluation is an assessment of long-term residual risks to be expected after remediation has been completed. Evaluation of the human health and environmental protection factor is generally based, in part, on the findings of an exposure assessment. The exposure assessment performed for this site incorporates the qualitative estimation of the risk posed by contaminants detected during the remedial investigation.

Evaluation of short-term impacts and effectiveness of each alternative examines health and environmental risks likely to exist during the implementation of a particular remedial action. Principal factors for consideration include the expediency with which a particular alternative can be completed, potential impacts on the nearby community and on-site workers, and mitigation measures for short-term risks required by a given alternative during the necessary implementation period.

Examination of long-term impacts and effectiveness for each alternative requires an estimation of the degree of permanence afforded by each alternative. To this end, the anticipated service life of each alternative must be estimated, together with the estimated quantity and characterization of residual contamination remaining on-site at the end of this service life. The magnitude of residual risks must also be considered in terms of the amount and concentrations of contaminants remaining following implementation of a remedial action, considering the persistence, toxicity and mobility of these contaminants, and their propensity to bioaccumulate.

Reduction in toxicity, mobility and volume of contaminants is evaluated on the basis of the estimated quantity of contamination treated or destroyed, together with the estimated quantity of waste materials produced by the treatment process itself. Furthermore, this evaluation considers whether a particular alternative will achieve the irreversible destruction of contaminants, treatment of the contaminants or merely removal of contaminants for disposal elsewhere.

Evaluation of implementability examines the difficulty associated with the installation and/or operation of each alternative on-site and the proven or perceived reliability with which an alternative can achieve system performance goals (primarily the SCGs discussed above). The evaluation examines the potential need for future remedial action, the level of oversight required by regulatory agencies, the availability of certain technology resources required by each alternative.

Cost evaluations presented in this document estimate the capital, and operation and maintenance (O&M) costs, including monitoring, associated with each remedial action alternative. From these estimates, a total present worth for each option is determined.

1.7 Approach to Feasibility Study

As discussed previously in this section, the focus of the OU2 RI/FS is the contaminated groundwater downgradient of an active dry-cleaning facility located at 123 Post Avenue, Westbury, New York. The technologies identified and evaluated in the next sections are technologies that are applicable to remediation of groundwater contaminated with volatile organic compounds. For the purposes of preparation of this feasibility study, it is assumed that the source of the contamination, the 123 Post Avenue Site, has been remediated and the focus of the feasibility study is to evaluate appropriate alternatives for remediation of the remaining off-site contaminant plume. As agreed upon with the NYSDEC, plume remediation will focus on remediation of the area of highly contaminated groundwater which has been defined as the area with concentrations of PCE greater than 500 ug/l. As also as agreed upon with the NYSDEC, groundwater remediation technologies being evaluated will include treatment for PFOA, PFOS and 1,4-dioxane since these emerging contaminants became listed in New York State after the remedial investigation was finalized. As the Big M Car Wash well has been identified as a complete exposure pathway, evaluation of appropriate remedial alternatives for this well will also be included in this feasibility study. Finally, as agreed upon with the NYSDEC and NYSDOH, a public water supply protection plan for N-5654 (Westbury Well 11) will also be evaluated as part of this feasibility study.

The contaminated groundwater at this site is overlain by a densely populated area, which is primarily residential and commercial. Consequently, the approach to this feasibility study will be to identify and evaluate technologies and alternatives which will be able to meet the remedial action objectives developed for the site, while at the same time meet the restrictive aboveground space limitations dictated by the study area. As discussed in the following sections, installation of any alternative will need to be completed within the right-of-ways of public roadways. Access to parking areas and commercial properties may not be obtainable. Therefore, preference may be given to technologies and alternatives that can be implemented given the aboveground constraints on space.

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2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

2.1 Introduction

In general, response actions which satisfy remedial objectives for a site include institutional, isolation, containment, removal or treatment actions. In addition, United States Environmental Protection Agency guidance under the Comprehensive Emergency Response, Compensation and Liability Act requires the evaluation and comparison of a no-action alternative to the action alternatives. Each response action for each medium of interest must satisfy the remedial action objectives for the site or the specific area of concern. Technologies and process options, which are available commercially and have been demonstrated successfully, are identified in this feasibility study along with selected emerging technologies. The screening of process options or technology types is performed by evaluating the ability of each technology to meet specific remedial action objectives, technical implementability, and short-term and long-term effectiveness. A discussion of selected response actions and their applicability to the 123 Post Avenue Site - OU2 is provided below. Preliminary evaluation/screening of the response action and remedial technologies will be based on technical effectiveness as it relates to the specific physical and chemical characteristics of the site. However, where appropriate, consideration will also be given to implementability and cost.

2.2 No Action

The no-action alternative will be considered, and as described above, will serve as a baseline to compare and evaluate the effectiveness of other actions. Under the no-action scenario, limited remedial response actions may be considered, including monitoring. Monitoring would consist of periodic groundwater sampling to evaluate changes over time in conditions at the site, and to ascertain the level of any natural attenuation which may occur or any increase in contamination which may necessitate further remedial action. Natural attenuation (under the no action alternative), as opposed to active remediation, relies on naturally occurring physical, chemical and biological processes (dilution, dispersion and degradation) to reduce contaminant concentrations.

2.3 Institutional Controls

Institutional controls potentially applicable to this site may include resource restrictions such as groundwater use restrictions to ensure that groundwater within the area of the plume is not utilized for potable, irrigation or industrial uses.

2.4 Groundwater Remediation Technologies

Treatment, collection and containment technologies, which could be applicable to remediation of groundwater contaminated with volatile organic compounds, such as those found at the 123 Post Avenue-OU2 Site, are identified and evaluated below.

2.4.1 Extraction Technologies

Extraction and treatment, or "pump and treat" technologies, are widely used for groundwater remediation and/or containment. Extraction is a remedial technology generally used in combination with aboveground treatment technologies to control and remove contaminants in groundwater. Two types of extraction technologies, pumping wells and interceptor trenches, are described below.

2.4.1.1 - Wells

Technology Description: The use of wells to pump contaminated groundwater to the surface for treatment is widely used as a remedial technology. With this technology, contaminated groundwater can be extracted for treatment and disposal. Groundwater modeling and/or pump tests are generally utilized to determine optimal pumping rates and well locations.

Initial Screening Results: Extraction wells represent a potentially viable technology for remediation of groundwater at the 123 Post Avenue Site.

2.4.1.2 – Interceptor Trenches

Technology Description: As opposed to wells, which can extract shallow and deep contaminated groundwater, interceptor trenches have been successfully used to extract groundwater in situations where the depth to groundwater is shallow, contamination is limited to the upper portion of the aquifer, and soils can be excavated without causing major disruption and structural damage and interfering with underground utilities.

Initial Screening Results: Although depth to groundwater at the 123 Post Avenue Site ranges from 39.4 to 45.6 feet below ground surface, the depth of the groundwater contamination being targeted is approximately 110 to 240 feet below ground surface. Due to the depth of the groundwater contamination being targeted, construction of deep interceptor trenches for groundwater remediation would be difficult and would not be as effective as extraction wells. Therefore, this technology will not be considered further.

2.4.2 Ex-Situ Treatment Technologies

Once extracted, contaminated groundwater must be treated to meet discharge standards. As discussed in Section 1.0, while the Feasibility Study is specifically targeting groundwater containing concentrations of PCE greater than 500 ug/l, elevated levels of other volatile organic compounds (VOCs), including trichloroethene and cis-1,2-dichloroethene, 1,4-dioxane, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were also detected.

Groundwater treatment technologies include biological, chemical and physical processes. Many of these processes can be combined to form an overall treatment system for groundwater. Groundwater treatment for metals, primarily iron and manganese, may be required prior to removal of VOCs in order to reduce operational difficulties, such as precipitation of iron and/or formation of iron bacteria during treatment which would clog the stripping media. Treatment technologies discussed in the following sections include biological, chemical and physical processes. Many of these technologies can be combined to form an overall treatment system for groundwater.

2.4.2.1 - Air Stripping

Technology Description: Air stripping involves a process by which volatile organic compounds are partitioned from groundwater by greatly increasing the surface area of the contaminated water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration and spray aeration. Air stripping is a widely used, proven and commercially available technology.

The applicability and effectiveness of air stripping depends on the potential for inorganic or biological fouling of the equipment. Clogging of the stripping column packing material or perforated trays due to inorganics in the groundwater (especially dissolved ferrous iron, which precipitates out as insoluble ferrous hydroxide species upon aeration) and biofouling (iron bacteria) are common problems if not taken into consideration during design. In addition, the Henry's Law constant of the organic compounds in the water stream will determine the effectiveness of air stripping.

Initial Screening Results: Air stripping represents a potentially viable technology for treatment of extracted groundwater at the 123 Post Avenue Site. As discussed above, air stripping is applicable to the treatment of VOCs and could be utilized as part of an overall treatment system for the site. Therefore, this technology will be retained for further evaluation.

2.4.2.2 - Carbon Adsorption (Liquid Phase)

Technology Description: Carbon adsorption involves a process by which groundwater is pumped through a series of canisters containing granular activated carbon to which dissolved contaminants adsorb. The technology requires periodic replacement or regeneration of saturated carbon. Carbon adsorption (liquid phase) is a widely used, proven and commercially available technology. The applicability and effectiveness of carbon adsorption may be limited by the presence of certain compounds which can foul the system, high contaminant concentration levels and the physical properties of the contaminants, among other factors.

Initial Screening Results: This technology has been very effective in the removal of VOCs and per- and polyfluoroalkyl substances (PFAS) compounds, including PFOA and PFOS, from contaminated groundwater which are associated with the 123 Post Avenue Site. Therefore, this technology will be retained for further evaluation as part of an overall treatment system for the site.

2.4.2.3 - Oxidation

Technology Description: Ultraviolet (UV) radiation, ozone and/or hydrogen peroxide may be used to destroy contaminants as groundwater flows into a treatment tank. An ozone destruction unit is used to treat off-gas from the treatment tank. UV oxidation is a commercially available technology which is effective in the treatment of volatile organic compounds.

Initial Screening Results: While oxidation is a potentially viable technology for treatment of extracted groundwater at the 123 Post Avenue Site, the high energy requirements associated with the use of technology limits its cost effectiveness. Therefore, this technology will not be retained for further evaluation.

2.4.2.4 - Biological Treatment

Technology Description: Typically, this technology involves the introduction of groundwater into biological treatment units where enzymes and microorganisms decompose organic contaminants into carbon dioxide, water and nonhazardous by-products. Supplemental nutrients may be added to assist the biological process. Biological treatment occurs at the rate of decomposition, which may be low. Biodegradation may also be accomplished in situ through the same biological processes.

Initial Screening Results: Biological treatment is generally less effective than available alternative technologies for chlorinated organic contaminants which are present in the groundwater at the 123 Post Avenue Site. Therefore, this technology will not be considered further.

2.4.2.5 - Reverse Osmosis

Technology Description: Osmosis is a process which occurs when two solutions of different solute concentrations reach an equilibrium across a semi-permeable membrane. The solvent (water in this case) will naturally flow from the less concentrated solution into the more concentrated solution. To reverse this process, the solution with the high concentrations must be pressurized to a level higher than the osmotic pressure. At sufficiently high pressures, usually 200 to 800 pounds per square inch (psi), the water will flow out of the more concentrated solution, leaving the contaminants trapped on the other side of the semi-permeable membrane. The volume of the concentrated waste is generally 10 to 20% of the feed volume. This concentrated waste will require additional treatment.

Reverse osmosis has been demonstrated to be effective for treatment of brackish waters, aqueous inorganic wastes and radionuclides, and recent findings indicate that it is useful in removing some specific organic compounds from solution. The effectiveness of this process is highly dependent on the chemical composition of the waste solution to be treated and the characteristics of the membrane.

Initial Screening Results: Since more effective and proven methods for treatment of volatile organic contaminants are readily available such as air stripping and carbon adsorption and large volumes of reject water would be generated using this technology, reverse osmosis will not be considered further.

2.4.2.6 - Filtration

Technology Description: Filtration is a process in which suspended and colloidal particles, which are not readily settleable, are removed from water by physical entrapment on a media. Fluid flow through the filter media may be accomplished by gravity or it may be pressure induced. Beds of granular material, such as sand and anthracite, are commonly used filters in groundwater treatment. Other types of filters include greensand filters for iron and manganese removal, vacuum filters, plate and frame filters, and belt filters. These filters are often used to dewater sludges produced by processes such as sedimentation and chemical precipitation. Packed beds of granular material are usually backwashed to remove the filter cake. The collected solids will require disposal and costs will depend on whether the material is hazardous or nonhazardous.

Initial Screening Results: Filtration is used to remove suspended solids and colloidal particles as part of a water treatment process. Therefore, this process will be retained for further consideration as part of an overall treatment system, in particular for iron removal.

2.4.2.7 - Chemical Precipitation and Clarification

Technology Description: Precipitation is a physical and chemical technique that can be used to remove metals from an aqueous stream. The metals can be precipitated out of solution by changing the chemical equilibrium of the solution. This is generally achieved by adding a chemical that reacts directly with the contaminant to form an insoluble settleable product. When used prior to other treatment technologies, this process eliminates the probability of reduced efficiency due to dissolved metals precipitation during later phases of treatment. The pH can be adjusted to optimize the precipitation process. Metals can be precipitated as hydroxides, carbonates and sulfides. Typical precipitating agents include calcium oxide, caustic soda, sodium sulfide, ferrous sulfide and hydrogen sulfide gas.

Initial Screening Results: Chemical precipitation may be utilized for the removal of inorganics as part of an overall groundwater treatment system. Therefore, this process will be retained for further consideration.

2.4.2.8 – Advanced Oxidation Processes (AOP)

Technology Description: This technologically destroys organic compounds that react with hydroxyl radicals by converting organic compounds into carbon dioxide, water and mineral acids. Commonly used AOP systems utilize oxidants such as hydrogen peroxide, ultraviolet (UV) light, and/or chlorine to destroy these compounds. For the purposes of this FS, the use of UV light in combination with hydrogen peroxide will be evaluated further. AOP with hydrogen peroxide utilizes hydroxyl radicals (OH- ions) as the mechanism to destroy organic compounds. Hydroxyl radicals react rapidly and non-selectively with electron-rich organic compounds. These radicals are produced through the reaction that occurs between the UV light and the hydrogen peroxide, known as hydrogen peroxide photolysis. The hydrogen peroxide/UV AOP treatment is conducted in a reactor designed to optimize the interaction between the hydrogen peroxide and UV light. The four mechanisms of chemical decomposition that occur within the reactor are photolysis of hydrogen peroxide, UV light adsorption to background influent water compounds, scavenging of the hydroxyl radicals by 1,4-dioxane and other influent compounds present, and photolysis of all compounds present in the influent water. AOP requires pre-treatment of water to prevent excessive lamp fouling if water is high in iron or nitrate.

The AOP effluent must be closely monitored to ensure that no undesirable effluent byproducts are generated. Byproducts can possibly be effectively removed by the installation of additional treatment technologies downstream of the AOP units. Unknown influent compounds may go through photolysis or react with the hydroxyl radical as well, potentially creating more harmful byproducts. For example, aldehydes and organic acids are commonly found post treatment. Several measures can be taken to minimize the risk of these byproducts entering the system. Due to the high dose of hydrogen peroxide needed for the creation of hydroxyl radicals, there is typically a high effluent concentration of hydrogen peroxide. In order to quench excess hydrogen peroxide from the effluent, it is necessary to install GAC vessels to remove hydrogen peroxide to safe levels. Another factor that must be considered is the natural organic matter present in the influent water into the AOP reactor. If the natural organic matter in the water is high, the UV light cannot penetrate it enough to generate sufficient photolysis. If this happens, fewer hydroxyl radicals are created, decreasing the efficiency with which 1,4-dixoane and other organic compounds are destroyed, thereby leaving additional residual hydrogen peroxide. AOP with hydrogen peroxide is a demonstrated and predictable treatment of chlorinated ethenes and 1,4-dioxane.

Initial Screening Results: AOP is one of the only technologies available to treat 1,4-dioxane and therefore will be retained for further consideration.

2.4.2.9 - Supply Well Treatment

Technology Description: This technology is potentially applicable for treatment of water from the car wash well. Groundwater extracted from the car wash water supply well (N-13350) is treated at the well head to meet NYSDEC Class GA discharge standards prior to its use. Treatment technologies include air stripping, carbon adsorption, oxidation and filtration. The aforementioned technologies and their initial screening results are discussed in detail in Section 2.4.2 – Ex-Situ Treatment Technologies.

Initial Screening Results: This technology will require aboveground space to house the treatment equipment, as well as long-term monitoring of the well and treatment equipment. Since there are more viable remedial technologies available, this technology will not be retained for further consideration.

2.4.3 Discharge Options

Groundwater extraction and treatment systems will generate a treated water discharge requiring proper management and disposal. Several discharge options are identified below. In addition, many of the treatment processes produce residuals that will require proper disposal.

2.4.3.1 - Publicly Owned Treatment Works

Technology Description: Under this option, treated, pretreated and/or untreated discharge would be routed to the Nassau County sanitary sewer system. The effluent would have to meet the County's discharge requirements.

Initial Screening Results: This option involves the discharge of extracted groundwater to a local POTW for treatment and subsequent discharge. In this part of Nassau County, the extracted groundwater would be directed to the Cedar Creek Water Pollution Control Plant (CCWPCP). A discharge approval would need to be obtained from CCWPCP and the treatment system would need to be designed to meet Nassau County discharge limitations. Once treated, the wastewater would be piped to an ocean outfall that is located in the Atlantic Ocean approximately six miles from the plant. Although discharge to the sewer system represents a potentially viable option for disposal of treated groundwater, preliminary conversations and coordination with Nassau County Department of Public Works, indicate it would not be able to accept wastewater at discharge rates greater than 200 gallons per minute (gpm). Since it is likely that higher volumes of groundwater will need to be extracted to meet remediation goals, this option does not appear to be feasible. Therefore, this technology will not be retained for further evaluation.

2.4.3.2 - Surface Water

Technology Description: Discharge to surface water would entail meeting the substantive requirements of a State Pollution Discharge Elimination System (SPDES) permit, which would require treatment to standards for discharge to a surface water, along with routine monitoring of the discharge. Construction of a piping system would be required to convey the treated discharge to the receiving surface water.

Initial Screening Results: There are no surface waters in the vicinity of the site. The closest surface waters that would potentially be able to accept the treated water are located in Hempstead, Freeport and Bellmore. These surface waters are located approximately 4.5 miles, 6.5 miles and 7 miles from the plume, respectively. Due to the locations of the identified surface waters with respect to the proposed locations of the extraction wells and treatment building this this technology will not be retained for further evaluation.

2.4.3.3 - Recharge/Reinjection

Technology Description: Recharge/reinjection options include discharge of treated groundwater to a recharge basin, injection wells or leaching pool(s). Again, the substantive requirements of a SPDES permit would need to be met. The use of existing or newly constructed recharge basins would allow treated groundwater to seep into the aquifer through permeable soils. The reinjection of the treated groundwater involves the use of injection wells to pump the treated effluent under pressure into the aquifer. This option, if implemented on or near the site would have to be evaluated with respect to potential impacts on the groundwater extraction strategy being implemented.

Initial Screening Results: There are many recharge basins located within Nassau County that may be able to receive a portion of the treated effluent, and additional recharge basins may be constructed to assist in discharging the treated effluent. The use of recharge basins in conjunction with injection wells will therefore be retained for further evaluation.

2.4.3.4 - Irrigation

Technology Description: Irrigation is a process which allows treated water to be discharged through land application or irrigation of vegetation on a seasonal basis. The use of irrigation to discharge treated effluent can be used in conjunction with other selected disposal methods.

Initial Screening Results: Eisenhower Red Golf Course and Eisenhower State Park are located in close proximity to the site and are potentially viable irrigation options for disposal of the treated effluent. However, as irrigation is not required year-round and groundwater extraction is expected to occur throughout the year, this technology will not be retained for further evaluation.

2.4.3.5 - Discharge to RCRA Disposal Facility

Technology Description: This disposal method involves the transport of extracted groundwater to a licensed RCRA facility for treatment and/or disposal.

Initial Screening Results: Due to the large volume of groundwater anticipated to be extracted and cost and logistics of transporting it to a RCRA approved facility for treatment and/or disposal, this technology will not be retained for further evaluation.

2.4.3.6 – Beneficial Reuse of Water

Technology Description: This method involves the transport of extracted groundwater to a facility for beneficial reuse.

Initial Screening Results: The Covanta Waste-to-Energy Hempstead facility is located in close proximity to the site and is a potentially viable beneficial reuse option for management of the treated effluent. Covanta uses approximately 1 million gallons per day of water for cooling in its waste-to-energy process and treated effluent from the groundwater extraction and treatment system could be used in their facility. Therefore, beneficial reuse of water will be retained for further evaluation.

2.4.4 In-Situ Treatment

In-situ treatment technologies for remediation of groundwater involve both proven and "emerging" or developing techniques as described below.

2.4.4.1 - Bioremediation

Technology Description: In-situ bioremediation of groundwater is a technology that modifies environmental conditions via biostimulation to encourage indigenous bacterial populations to metabolize target contaminants. In-situ bioremediation of chlorinated hydrocarbons can be completed through an anaerobic reductive dechlorination process. Anaerobic conditions can be created in the subsurface through the addition of a readily biodegradable organic compound to utilize all of the oxygen present and create reducing conditions to stimulate anaerobic bacteria. Liquid delivery of emulsified vegetable oils is one of the most common applications of engineered in-situ bioremediation to remediate sites contaminated with chlorinated hydrocarbons. Anaerobic reductive bioremediation relies on the presence of biologically available organic carbon, or an electron donor source, which creates and sustains anaerobic conditions by consuming oxygen and other electron acceptors during its biodegradation. Anaerobic conditions may be used to degrade highly chlorinated contaminants such as tetrachloroethene.

Complete degradation of the chlorinated compounds requires close monitoring of the groundwater plume. In order to ensure complete dechlorination and not the production of more toxic compounds such as vinyl chloride, some sites may also need to be augmented with a microbial culture capable of degrading the contaminants along with substrate and/or nutrient injection. Aerobic bioremediation can be used to complete biodegradation of the partially dechlorinated compounds, such as vinyl chloride.

For best results, factors that must be considered for bioremediation include redox conditions, saturation rates, presence of nutrient trace elements, pH, temperature and permeability of the subsurface materials. If nutrients, such as nitrogen and phosphorous, are not present in sufficient amount, they can be added to the subsurface. In order to maintain subsurface conditions conducive for anaerobic bioremediation activity, several injection events for the application of the organic substrate, pH buffer and microbes are likely. The maximum radius of influence for emulsified vegetable oil is generally 25 to 40 feet and is ultimately dependent on the depth of injection, soil matrix, injection equipment, volume of chase water applied and oil retention in soil. Similar to the other in-situ remedial technologies discussed in this section, subsurface anomalies, such as low permeability zones, can impact the effective distribution of required materials in the subsurface. In-situ bioremediation is a full-scale commercially available technology. However, effective distribution of the substrate is required for successful remedial efforts.

Initial Screening Results: In order to effectively treat the PCE plume, two (2) 450-foot long biobarriers would be recommended. Each biobarrier would include approximately 20 locations with 5 injection intervals per location for a total of 200 injection wells. A large number of wells is required due to the size and depth of the PCE plume. Based on the location of the plume, two potential locations for the biobarriers are Corporate Drive and the entrance ramp of the Meadowbrook Parkway. Based on the plume size and depth, concentration of PCE and number of injection wells, the bioremediation program would run for approximately 430 days and require over 4 million pounds of EVO and 6 million gallons of chase water to complete. Due to the site conditions and the limited real estate to install the injection wells and stage equipment to implement the remedy; adequate distribution of the required materials to ensure effectiveness of this technology will be difficult. Therefore, based on the limitations of in-situ bioremediation, including reagent distribution and anticipated injection events, this technology will not be retained for further consideration.

2.4.4.2 - Chemical Oxidation

Technology Description: Chemical oxidation involves the use of an oxidant to treat or destroy organic contaminants in groundwater. Various types of oxidants have been used including hydrogen peroxide and sodium permanganate. The following provides a brief description of each oxidant and its use.

Hydrogen peroxide is typically used in conjunction with ferrous iron to produce hydroxyl radicals which can break the carbon-hydrogen bonds of organic molecules allowing this reaction to degrade chlorinated solvents, polyaromatic hydrocarbons and petroleum products. Since it is a destruction process, there is no potential for intermediate chlorinated, potentially more toxic compounds to be produced as in the bioremediation process discussed in Section 2.4.4.1. Some of the disadvantages of the use of hydrogen peroxide is the hazardous nature of handling hydrogen peroxide, the potential for reduction of permeability of the saturated zone due to formation of metal oxide precipitates during the reaction and difficulties with delivery of the hydrogen peroxide to the contaminated zone, since it can easily breakdown to water vapor and oxygen. The reaction is typically exothermic and can cause the mobilization of nonaqueous phase liquid, if present, to the dissolved state in groundwater and the release of off-gases. The use of various catalysts and mobility control agents has been shown to better control the increase in temperature and mobility of contaminants.

Sodium permanganate can react with organic compounds to produce manganese dioxide and carbon dioxide. Sodium permanganate has been shown to oxidize chlorinated volatile organic compounds, as well as alkenes, aromatics, polycyclic aromatic hydrocarbons (PAHs), phenols, pesticides and organic acids. Sodium permanganate is more stable than hydrogen peroxide and is easier to handle; however, there is a potential for permeability reduction due to the formation of metal oxide precipitates during the reaction. Unlike hydrogen peroxide, sodium permanganate is only consumed by interaction with contaminants or natural organic material.

A primary concern with the use of strong oxidants is the corrosive and potentially explosive (i.e., hydrogen peroxide) characteristics of the oxidant. Design and operation of the chemical oxidation system must take into account the potential hazards of the chemicals used to ensure protection of health and safety of operational personnel and residents in the vicinity of the remediation system.

Several vendors are currently utilizing various forms of the above processes to treat contaminated groundwater and, as a result, it has full-scale application and is commercially available. For chemical oxidation to be effective, the oxidant must come into direct contact with the contaminants of concern. This remedial approach would require several injections over time to ensure contact with the contaminants of concern and groundwater sampling and analysis.

Factors associated with the effective implementation of this process include detailed understanding of the nature and extent of contamination in order to effectively place the chemical oxidant. Subsurface anomalies can potentially short circuit the system if not adequately considered. The oxidants are also nonselective to both organic contaminants and natural organic matter. The presence of high natural organic matter content in the soils could consume a large portion of the oxidants making treatment less economically feasible. It should be noted that a bench scale treatability study completed for the site in February 2004 did not indicate elevated levels of organic carbon. However, the total organic carbon samples were collected from a different area of the site and at a different depth. Therefore, it is recommended that an additional bench scale treatability study be performed with additional representative samples for the area being treated.

Initial Screening Results: The success of chemical oxidation is dependent upon the ability of the chemical oxidant to contact the contaminated groundwater. Similar to bioremediation, site conditions and limited real estate to install injection wells and stage required equipment present a challenge to effectively implementing this remedy. However, unlike bioremediation, chemical oxidation is a proven technology that if properly implemented will be more effective than bioremediation. Therefore, due to its potential ability to treat the groundwater contaminants of concern at the 123 Post Avenue site, limited disruption to the surface and no aboveground space requirements, chemical oxidation with sodium permanganate will be considered further. Due to concerns regarding the use of hydrogen peroxide in the commercial and residential area of the study area, the use of this oxidant will not be considered further.

2.4.4.3 - Permeable Reactive Barriers

Technology Description: The use of permeable reactive barriers (PRBs) involves installing a permeable barrier across the flow path of a contaminant plume, which allows the plume to passively move through the barrier. Typically, the contaminants are degraded by reactions with a mixture of porous media and a metal catalyst. Zero valent iron (ZVI) can be used as the reactive medium for the treatment of chlorinated ethenes. As the iron is oxidized, a chlorine atom is removed from the chlorinated ethene by one or more reductive dechlorination mechanisms, using electrons supplied by the oxidation of iron. The iron granules are dissolved by the process, but the metal disappears so slowly that the remediation barriers can be expected to remain effective for many years, possibly even decades. Another reactive medium that can be used in lieu of ZVI is Provect-IR, which is a proprietary blend of zero valent iron and organic carbon manufactured by Provectus. Provect-IR promotes anaerobic biodegradation and reductive dechlorination of halogenated solvents in groundwater. PRBs are generally intended for long-term operation to control the migration of contaminants in groundwater. However, based upon the site conditions and depth of contamination, PRBs would need to be installed with cased borings via sonic drilling that will distribute the iron across the width of the plume.

Initial Screening Results: PRB's are effective if they are installed across the entire flow path of the contaminant plume. The thickness of the plume is generally greater than 100 feet and the depth of the plume is between 115 feet and 240 feet below. Additionally, the PCE plume is approximately 2,400 feet long by 450 feet wide. Based on these dimensions, two approximately

1,000-foot PRB's would be recommended to capture the entire plume. Approximately 20 to 25 borings would be needed for each PRB. Due to the high-density area that the plume is located in and the depth of contamination, this technology will not be considered further.

2.4.4.4 - Natural Attenuation with Well Modification, Sentinel Well Installation and Long-Term Monitoring

Technology Description: Natural attenuation is an alternative whereby natural processes, such as dilution, dispersion, volatilization, biodegradation, adsorption and chemical reactions with subsurface materials, are allowed to reduce contaminant concentrations to acceptable levels. Consideration of this option requires evaluation of contaminant degradation rates to determine the feasibility and special regulatory approvals that may be needed. In addition, groundwater sampling and analysis must be conducted throughout the process to confirm that attenuation is proceeding at a rate consistent with meeting cleanup objectives and that any potential receptors will not be impacted. Several disadvantages of natural attenuation include: generation of intermediate degradation products that may be more mobile and more toxic than the original contaminant; it should be considered only where there are no potential impacts on receptors; contaminants may migrate before they are degraded; regulatory agency acceptability is generally not favorable; and community acceptability is generally poor, in particular, where it is the only remediation measure proposed. The car wash water supply well (N-13350) that is currently installed is a 200 foot well screened from 180 to 200 feet below grade surface. This technology would include the installation and development of a new water supply well screened from a different depth to avoid extracting groundwater from within the PCE plume. The new water supply well would need to provide a maximum yield of 40 gallons per minute, consistent with the existing water supply well. Upon modification of the well, the existing water supply well can be decommissioned in accordance with NYSDEC CP-43 Groundwater Monitoring Well Decommissioning Policy. Finally, Westbury Well 11 (N-5654) does not currently have any treatment prior to distribution and is screened from 474 to 538 feet below grade surface. While this well is not currently impacted by the plume based on its depth in relation to the plume depth, this technology would include installation of three sentinel wells at similar screened depths for the purpose of detecting contaminants in groundwater before they are captured by the public water supply well.

Initial Screening Results: Data collected during the remedial investigation indicates that the groundwater plume at the 123 Post Avenue site is not currently impacting public water supply wells due to its location and depth. However, Westbury Well 11 (N-5654) does not have any treatment and the plume could potentially be captured by the supply well based on the well's pumping influence and also potential for diving contamination. The installation of a network of sentinel wells will provide an opportunity to detect contaminants in groundwater before they are captured by the public water supply well. Additionally, the car wash water supply well has a complete human exposure pathway. The modification of existing car wash supply well is a common and straightforward technology that is applicable to addressing contaminated groundwater being extracted and used from the car wash. Other than the car wash water supply well, the groundwater plume does not have a complete human exposure pathway. Therefore, natural attenuation with well modification, installation of sentinel wells and long-term monitoring to continue to monitor and track the projected location of the groundwater plume will be retained for further consideration.

A summary of the identification and screening of the technologies discussed above is presented in Table 2-1 provided at the end of this section.

2.5 Summary Evaluation of Remediation Technologies

Based on the screening of remedial technologies, provided below is a summary of the technologies that are retained for further consideration, either as remedial alternatives in and of themselves, or in combination with other technologies to form alternatives. In addition to the below listed technologies, no action will also be evaluated further.

- Groundwater extraction and treatment with well modification, installation of sentinel wells and long-term monitoring

- Chemical oxidation (sodium permanganate) with well modification, installation of sentinel wells and long-term monitoring
- Natural attenuation with well modification, installation of sentinel wells and long-term monitoring

Table 2-1

INITIAL SCREENING OF REMEDIATION TECHNOLOGIES
123 POST AVENUE SITE - OPERABLE UNIT 2

General Response Action	Remedial Technology	Description	Summary of Initial Screening Results
Ex-situ Treatment	Groundwater Extraction and Treatment	Extraction Technologies: Extraction wells or interceptor trenches are constructed and contaminated groundwater is pumped to the surface for treatment.	Extraction wells are retained for further consideration due to the technology's potential applicability to the contaminants of concern. Interceptor trenches are not retained due to the depth of groundwater contamination being targeted.
		Ex-Situ Treatment Technologies: Biological, chemical and physical processes used to treat the contaminated groundwater in order to meet discharge standards.	Air stripping, carbon adsorption, filtration and advanced oxidation processes are potentially viable treatment technologies for the contaminated groundwater and will be retained for further consideration. Oxidation, biological treatment and reverse osmosis will not be retained due to energy costs and effectiveness at treating the contaminated groundwater.

General Response Action	Remedial Technology	Description	Summary of Initial Screening Results
		Discharge Options: Groundwater extraction and treatment will generate a treated water discharge that requires proper management and disposal.	Recharge, reinjection and beneficial reuse will be retained for further consideration as there are recharge basins in the vicinity of the site and additional recharge basins can be constructed. Facilities that could accept treated effluent for reuse are in close proximity to the site. POTW, surface water, irrigation and discharge to a RCRA disposal facility will not be retained for further consideration due to the high volume of groundwater that is anticipated to be extracted and lack of surface waters in close proximity to the site.
	Treatment at the Well Head	Groundwater extracted from the car wash water supply well will be treated prior to use.	Although this technology would be applicable to the contaminants of concern at the site, it will require space for aboveground treatment equipment and long-term maintenance of the treatment system. Since there are more viable remediation technologies available, this technology will not be retained for further consideration.
	Supply Well Modification	The existing water supply well for car wash will be decommissioned and a new water supply well will be installed at a different depth to avoid extracting contaminated water.	Retained for further consideration due to the technology's potential applicability to the contaminants of concern, limited disruption to surface and no aboveground space requirements.

General Response Action	Remedial Technology	Description	Summary of Initial Screening Results
In-situ Treatment Technologies	Bioremediation	Anaerobic conditions are created in the subsurface through the injection of readily biodegradable organic compounds and the VOCs are degraded through anaerobic decomposition.	Not retained for further consideration due to site constraints associated with access limitations for the installation of the number of injection wells required to ensure the necessary distribution of the substrate within the subsurface.
In-situ Treatment Technologies (continued)	Chemical Oxidation	Oxidants are injected into the groundwater to treat organic contaminants.	Chemical oxidation shares similar challenges with bioremediation; however, it is a proven technology that will be effective if properly implemented. Therefore, it is retained for further consideration due to the technology's potential applicability to the contaminants of concern, limited disruption to surface and no aboveground space requirements.
	Permeable Reactive Barrier with Zero Valent Iron	A permeable reactive wall typically injected with zero-valent iron is installed across the flow path of the plume treat organic contaminants.	Although permeable reactive barriers with zero valent iron are potentially effective in removing site contaminants, it is not implementable due to the depth of contamination and high-density commercial/residential nature of the area. Therefore, this technology will not be retained for further consideration.

General Response Action	Remedial Technology	Description	Summary of Initial Screening Results
	Natural Attenuation with Well Modification, Sentinel Well Installation and Long Term Monitoring	Natural subsurface degradation processes reduce contaminant concentrations.	Data from the remedial investigation shows that the plume is not impacting public water supply wells and currently the only complete human exposure pathway is associated with the car wash well. However, water supply well N-5654 does not currently have treatment and sentinel wells can be used to detect contaminants in groundwater before they are captured by the well. Therefore, natural attenuation with well modification, installation of sentinel wells and long term monitoring to continue to monitor and track the plumes projected path will be retained for further consideration as an appropriate technology.

3.0 DEVELOPMENT AND PRELIMINARY EVALUATION OF ALTERNATIVES

Based on the screening of remedial technologies in Section 2.0, the next phase of the feasibility study process is to develop remedial alternatives for preliminary evaluation based on effectiveness, implementability and relative cost. These alternatives can comprise either a single technology, if only one medium at a site is of concern and/or only one treatment process is required, or a combination of technologies.

As described previously, the media of concern at the 123 Post Avenue site - Operable Unit 2 is groundwater contaminated with tetrachloroethene (PCE) greater than 500 ug/l downgradient of the source area. Additionally, perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS) and 1,4-dioxane are being evaluated as part of this feasibility study since these emerging contaminants became listed compounds after the remedial investigation was finalized. Soil and groundwater contamination in the source area has been addressed under the remedial action for Operable Unit 1. The following alternatives focus on remediation of the off-site contaminant plume.

3.1 Description of Remedial Alternatives

3.1.1 Alternative 1 - No Action

The no-action alternative will be considered and serve as a baseline to compare and evaluate the effectiveness of other actions. Natural attenuation (under the no-action alternative), as opposed to active remediation, relies on naturally occurring physical, chemical and biological processes (dilution, dispersion and degradation) to reduce contaminant concentrations. A detailed cost estimate for Alternative 1 is provided in Appendix A.

3.1.2 Alternative 2 – No Action with Well Modification, Installation of Sentinel Wells and Long-term Groundwater Monitoring

This alternative includes the no action alternative described above with the addition of modification of the car wash well and installation of sentinel wells near Westbury Well 11. This alternative includes installation and development of a new water supply well for the car wash, as discussed in Section 2.0, to avoid extracting groundwater from within the PCE plume. The car wash water supply well (N-13350) that is currently installed is a 200 foot well screened from 180 to 200 feet below ground surface. As discussed in Section 1.0, the car wash water supply well was sampled three times during the Remedial Investigation and sampling indicates the presence of PCE. Based on the depth of the PCE plume, a new commercial well can be installed at a different depth to avoid the plume. Upon construction and development of the new commercial well, the existing can be properly abandoned in accordance with state and local requirements. Westbury Well 11 (N-5654) does not currently have any treatment and the installation of three sentinel wells at similar depths will allow for the detection of contaminants in groundwater before they are captured by the well.

Aside from modification of the water supply well and installation of three sentinel wells, this alternative provides no active remediation for the groundwater and relies solely on natural attenuation. It should be noted that the contaminant plume does not currently impact any public water supply wells. Long-term groundwater monitoring would allow the NYSDEC to evaluate the contaminant plume and monitor its migration. Long-term groundwater monitoring will involve semiannually sampling of at least one well upgradient of the 500 ug/l PCE plume, and three wells downgradient of the 500 ug/l PCE plume for the first 10 years, annually for the next 10 years, and biannually for the following 10 years. Analysis of the groundwater samples will be for VOCs, 1-4-dioxane and per- and polyfluoroalkyl substances (PFAS). Existing wells will be utilized as appropriate for monitoring and new wells will be installed at locations and depths to appropriately monitor the plume. The exact location and depths of the wells to be utilized for long term monitoring will be determined as part of the remedial design utilizing current groundwater sample data. For the purposes of this alternative, it is assumed that three new wells, approximately 400 feet in depth, will be installed to monitor the plume. A detailed cost estimate for Alternative 2 is provided in Appendix A.

3.1.3 Alternative 3 – Groundwater Extraction and Treatment with Well Modification, Installation of Sentinel Wells and Long-term Groundwater Monitoring

Alternative 3 includes implementation of a groundwater extraction and treatment system, well modification at the car wash water supply well, installation of sentinel wells near Westbury Well 11 and long-term groundwater monitoring. Prior to installation of a groundwater extraction and treatment system, a pumping test will need to be performed to determine the hydraulic characteristics of the aquifer in the vicinity of the site in order to design an effective groundwater extraction system, including number of wells, well spacing and pumping rates to remediate the contaminant plume. For the purposes of this alternative, it is assumed that a minimum of four observation wells and one extraction well will need to be installed to perform the pump test. The pump test will run continuously for 24 hours at varying extraction rates. Groundwater elevations will be recorded continuously in the new observation wells, the pumping well and any existing groundwater monitoring wells in the vicinity of the extraction well. Groundwater samples will also be collected during the pumping test to evaluate water quality.

Without the results of the pump test, data obtained from water district wells located within the vicinity of the site was utilized to estimate the number of groundwater extraction wells, extraction rate and radius of influence that will allow for capture of the contaminated groundwater plume. Accordingly, it is anticipated that containment of the groundwater can be accomplished by the utilization of three to four extraction wells across the length of the 500 ug/l PCE plume. The PCE plume is located in a high-density area with limited accessible space to install the extraction wells. Based on the location of the plume, the groundwater flow direction and site constraints, the groundwater extraction wells can potentially be constructed on Ellison Avenue, Corporate Drive and the entrance ramp of the Meadowbrook Parkway (see Figure 3-1). Construction of the extraction wells in this location will require approval and coordination with the New York State Department of Transportation. It is estimated that each of the wells would need to extract approximately 500 -750 gpm, for a total of 2,000 gpm to contain the plume and prevent its continued migration. The location, depth and flow rate for each of the extraction wells would need to be refined during the remedial design.

NOTES

1. ALL CONCENTRATIONS SHOWN ARE IN MICROGRAMS PER LITER (ug/l)
2. PCE ISOCONTOURS WHERE DETERMINED DURING THE RI FROM MONITORING SAMPLE RESULTS FROM DECEMBER 2017–FEBRUARY 2018.
3. EXISTING MONITORING WELLS, WATER SUPPLY WELLS, AND CONCENTRATIONS OF PCE FROM THE SAMPLING EVENT ARE NOT SHOWN FOR CLARITY.
4. THE PROPOSED LOCATIONS FOR THE GROUNDWATER EXTRACTION WELLS, TREATMENT BUILDING AND RECHARGE BASIN ARE APPROXIMATE.

LEGEND

⌖ PROPOSED EXTRACTION WELL LOCATION

—5— APPROXIMATE PCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED.

0 300'
SCALE: 1"=300'

D&B ENGINEERS AND ARCHITECTS, P.C.

123 POST AVENUE - OPERABLE UNIT 2
WESTBURY, NEW YORK

SCALE: 1"=300'

ALTERNATIVE 3- GROUNDWATER EXTRACTION AND TREATMENT
PROPOSED EQUIPMENT LOCATIONS

FIGURE 3-1

The extracted groundwater will be treated for PCE; however, groundwater in the vicinity of the site also has concentrations of TCE,1,2-DCE, 1-4-dioxane, PFOA and PFOSabove their respective MCL's. It is anticipated that extracted groundwater will also have to be treated for these contaminants in order to be discharged to the aquifer via recharge basins and/or injection wells or conveyed to a nearby facility for beneficial reuse. Once extracted, groundwater will be treated through the use of air stripping. In addition, based on information obtained from local water suppliers, pretreatment of groundwater will likely be required for the removal of iron and manganese prior to treatment for PCE removal in order to prevent fouling of the air stripping system and ensure effective operation of the remediation system. Based on experience with the installation of water supply wells and treatment systems on Long Island, the treatment process selected to address the contaminants of concern as part of this alternative are the following in sequence from influent to effluent: mixed media filter, bag filter to remove suspended solids, aeration tower for bulk VOC removal, advanced oxidation process (AOP) system for 1,4-dioxane removal and polishing VOCs and granular activated carbon (GAC) for PFOA and PFOS removal, GAC is also effective in removing hydrogen peroxide to safe levels, and therefore is required for water treated by the UV/hydrogen peroxide AOP system. As the plume is located in a high-density area, there is limited real estate for installation of the groundwater extraction wells and treatment building. In order to minimize underground piping that will be required to convey extracted groundwater to the treatment building, the treatment building should ideally be located in the vicinity of at least one of the groundwater extraction wells. Based on the location of the contaminant plume, proposed locations of the extraction wells and the direction of groundwater flow, one viable location for the treatment plant is the open space near the entrance ramp of the Meadowbrook Parkway (see Figure 3-1). Treated water would need to be conveyed from the treatment building to a newly constructed recharge basin. The recharge basin should also be constructed in the vicinity of the extraction wells and treatment building to minimize underground piping that will be required to convey treated water to the recharge basin. Due to the high-density area that the plume is located in, land acquisition may be required in order to construct a recharge basin. As discussed in Section 2.0, there is also a potential opportunity for the beneficial reuse of approximately 1,000,000 gallons per day of the treated water by the nearby Covanta facility. If an agreement is made between the NYSDEC and Covanta to reuse the treated water, the treatment plant should also be located near the facility to minimize underground piping that will be required to convey the treated water to Covanta. Treated water could be conveyed to Covanta via underground piping and then pumped into holding tanks on the property for use in their cooling operations. The anticipated treatment process is described below:

- Water from the individual extraction wells would be pumped to the treatment plant via multiple piping networks or a single larger diameter manifold pipe. A pump station with an appropriately sized pump would also be used within the piping network to transfer groundwater to the treatment plant if necessary.

- After the pumped groundwater has been metered at the treatment plant, it will enter a mixed media filter to remove iron/manganese precipitates. Based on the total flow rate and anticipated concentrations of iron and manganese based on available regional data, three mixed media filter units would be used to remove iron/manganese precipitates from the influent groundwater. In order to address iron and manganese the options that were considered include sequestering, chemical precipitation, green sand filters and mixed media filters. If this alternative is selected bench scale testing should be done to confirm the most appropriate means for removal of iron and manganese. However, for the purposes of the feasibility study, a mixed media filter was selected based on conversations and coordination with vendors.

- Groundwater from the mixed media filters will be transferred to four dual-stage bag filters to remove suspended solids prior to being transferred to the air strippers.

- Groundwater from the bag filters will be transferred into air strippers for PCE treatment. Based on the location of the treatment plant, influent concentrations and flow rates it is assumed that a vapor-phase GAC network is not required; however, this should be confirmed during the design if this alternative is selected. Based on the total flow rate, four parallel operated air stripper units with five trays will be used for the removal of PCE in groundwater. Process air heaters and blowers, and pumps are assumed as part of the air stripping system. PCE removal options that were evaluated as part of this feasibility study included aeration tanks, packed towers and sieve trays. If this alternative is selected, during design all available options should be evaluated further to confirm the most appropriate option for PCE removal.

- Treated groundwater will be transferred to the AOP system for 1,4-dioxane removal. The AOP system was selected based on the flow rate and 5 times the historical maximum concentration of 1,4-dioxane from the remedial investigation. Two trains of AOP reactors with four banks for UV lamps, which incorporates the injection of an oxidizing agent (i.e., hydrogen peroxide) and the utilization of UV light will be used for the removal of 1,4-dioxane. The AOP system consists of UV transmittance monitors, control power panels, hydraulic system centers, flow meters, a system control center and hydrogen peroxide analyzers. If this alternative is selected, during design a pilot study should be completed to obtain representative water quality data from an extraction well that can be used to determine the precise parameters of the full scale AOP system. In addition, the pilot study should incorporate sampling for any potential harmful byproducts of the AOP process so that their treatment can be included in the full-scale design of the facility.

- Liquid effluent from the AOP process would then pass through a liquid-phase GAC network for PFAS removal, including PFOA and PFOS, and hydrogen peroxide removal. Based on the total flow rate for this alternative, two parallel trains of two liquid GAC vessels in series would be used for the removal of groundwater contaminants. A lead-lag system would be used to allow continuous operation during GAC change-out periods.

Treated groundwater would need to be returned to the aquifer or conveyed to a nearby facility for beneficial reuse. There is a potential opportunity for the beneficial reuse of approximately 1,000,000 gallons per day of the treated water by the nearby Covanta facility. If the NYSDEC and Covanta can formulate an agreement for beneficial reuse of treated groundwater it will significantly reduce the amount of water that needs to be returned to the aquifer. Recharge basins would be the preferred discharge option for the remaining water and it may be possible to construct a recharge basin in the vicinity of the treatment building depending on the availability of space. However, due to the high volume of water being discharged, treated water may need to be piped to existing recharge basins. Costs for the construction of a new recharge basin has been included within the estimated costs. The location for the new recharge basin will have to be evaluated in order to identify a location in the vicinity of the treatment building with sufficient space to accept the volume of water being treated; however, the location would be finalized during the remedial design.

The construction of this alternative is estimated to take approximately 1 to 2 years.

In addition to the above, this alternative also includes modification of the water supply well at the car wash, as discussed in Section 3.1.2 as the groundwater extraction and treatment system will be located downgradient of the car wash well and will not address the contamination at the car wash well. This alternative also includes the installation of three sentinel wells near Westbury Well 11 (N-5654), as discussed in Section 3.1.2.

Long-term groundwater monitoring will be conducted to evaluate the effectiveness of the groundwater extraction and treatment system. Long-term groundwater monitoring will involve the sampling of at least one upgradient well from the 500 ug/l PCE plume and three downgradient wells from the 500 ug/l PCE plume. These wells will be sampled quarterly for select VOCs, 1-4-dioxane and PFAS for the first 10 years, semi-annually for the next 10 years and annually for the remaining 10 years.

Long-term operation and maintenance (O&M), including operational labor, power and material and chemical usage, would also be required for the treatment system for approximately 30 years. O&M includes labor costs for personnel to inspect the treatment equipment, provide oversight during material/chemical replacement, and collect samples of the effluent. The treatment system has costs associated with annual power usage for extraction pumps, air stripper blowers, AOP processes, transfer pumps and operating the treatment plant building. There are also costs associated with replacing media for the mixed media filters and bag filters, UV bulb replacement, hydrogen peroxide and regenerating spent granular activated carbon. A detailed cost estimate for Alternative 3 is provided in Appendix A.

3.1.4 Alternative 4- In-situ Chemical Oxidation with Well Modification, Installation of Sentinel Wells and Long-term Groundwater Monitoring

This alternative includes in-situ chemical oxidation, well modification, installation of sentinel wells and long-term groundwater monitoring. As discussed in Section 2.0, in-situ chemical oxidation is a potentially viable alternative for the reduction of VOCs in groundwater at the site. For this alternative, sodium permanganate is injected into the contaminated groundwater causing a reaction which produces manganese dioxide and carbon dioxide. The effectiveness of the technology is dependent upon delivery of the oxidant to the contaminated groundwater.

In order to deliver sufficient oxidant to the subsurface within the plume, three arrays of injection points will be installed in the vicinity of monitoring well OU2-18-VPB2, monitoring well OU2-19-VPB1 and the entrance ramp of the Meadowbrook Parkway. Each array will include 8 injection locations with 7 wells installed per location (see Figure 3-2). The thickness of the plume is generally greater than 100 feet and the depth of the plume is between 115 feet and

240 feet below. The PCE plume is approximately 2,400 feet long by 450 feet wide. Based on the plume dimensions and depth, injection points will be nested to address the entire thickness of the plume. Accordingly, 168 injection wells are anticipated to be required for this remedy to remediate the entire contaminant plume. Since the site is located in a densely developed commercial area, it is unlikely that there will be enough accessible open space to install all the required injection points and wells in right of ways and access to private property may be required. It is assumed that the injection points will have a 20 to 40-foot horizontal radius of influence and a 10 to 20-foot vertical radius of influence. Each injection point will be constructed using sonic drilling and will comprise permanent well points that can be reused for additional injections. Injection points will be constructed using 2.5-inch diameter PVC casing and screens and will be accessible by flush-mount lockable manholes. Approximately 14,000,000 pounds of 40% sodium permanganate will be injected into the groundwater during the injection period which is anticipated to take approximately 1 to 2 years to complete. Injection of permanganate into groundwater will change the color of the groundwater to purple and will also create manganese dioxide particulates that appear as particles of rust in the groundwater.

Since all work will be performed in-situ, there will be no aboveground treatment equipment required. Sampling of the groundwater within the treatment zones during the remediation process will be required in order to evaluate the effectiveness of the alternative. It is assumed that five additional groundwater monitoring wells at varying depths and locations will be installed within the study area to monitor the effectiveness of this alternative. Samples will be collected from the newly installed monitoring wells and existing wells in the study area. Samples will be collected quarterly for a two-year period beginning one month after the injections are completed. Samples will be analyzed for VOCs, manganese, chloride, permanganate concentration, color, temperature and pH.

NOTES

1. ALL CONCENTRATIONS SHOWN ARE IN MICROGRAMS PER LITER (ug/l)
2. PCE ISOCONTOURS WHERE DETERMINED DURING THE RI FROM MONITORING SAMPLE RESULTS FROM DECEMBER 2017–FEBRUARY 2018.
3. EXISTING MONITORING WELLS, WATER SUPPLY WELLS, AND CONCENTRATIONS OF PCE FROM THE SAMPLING EVENT ARE NOT SHOWN FOR CLARITY.
4. THE PROPOSED CHEMICAL INJECTION LOCATIONS ARE APPROXIMATE.

LEGEND

—5— APPROXIMATE PCE CONCENTRATION ISOCONTOUR IN UG/L, DASHED WHERE INFERRED.

0 300'
SCALE: 1"=300'

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ALTERNATIVE 4- IN-SITU CHEMICAL OXIDATION
PROPOSED INJECTION LOCATIONS

SCALE: 1"=300'

FIGURE 3-2

Since chemical oxidation is essentially an instantaneous process, remediation will be completed once the installation, injection and monitoring is completed. Installation, injection and monitoring of this alternative is anticipated to be completed within 4 years of mobilization to the site.

In addition to the above, this alternative also includes modification of the water supply well at the car wash, as discussed in Section 3.1.2 as the groundwater extraction and treatment system will be located downgradient of the car wash well and will not address the contamination at the car wash well. This alternative also includes the installation of three sentinel wells near Westbury Well 11 (N-5654), as discussed in Section 3.1.2.

Following treatment, further groundwater monitoring will be required to evaluate the effectiveness of the alternative over the long term. Long-term groundwater monitoring will involve the sampling of at least two upgradient wells from the 500 ug/l PCE plume and three downgradient wells from the 500 ug/l PCE plume that were installed as part of this alternative to monitor the effectiveness of chemical oxidation. These wells will be sampled semiannually for select VOCs for the first 5 years annually for the remaining 5 years. A detailed cost estimate for this Alternative is provided in Appendix A.

3.2 Preliminary Evaluation of Alternatives

3.2.1 Alternative 1

Effectiveness

Alternative 1, no action, would not meet any of the remedial action objectives established for the 123 Post Avenue site, as discussed in Section 1.5 of this document, since groundwater standards will not be achieved. This alternative relies solely on natural attenuation of contamination, which is not expected to occur in a significant manner based on existing data.

Implementability

This alternative is readily implementable physically; however, since no action does not mitigate the migration of contaminated groundwater or exposure to contaminated groundwater, it is not implementable from a regulatory perspective.

Cost

The cost for of this alternative is significantly lower than the action alternatives discussed below.

3.2.2 Alternative 2

Effectiveness

Alternative 2, no action with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, would be protective of human health and the environment and would prevent further migration of contaminated groundwater associated with the existing water supply well at the car wash. The installation of sentinel wells near Westbury Well 11 (N-5654) will allow for detection of contaminants in groundwater before they are potentially captured by the untreated water supply well. However, beyond addressing the water supply well for the car wash, this alternative would not remediate the contaminated groundwater plume and therefore not achieve remedial action objectives established for the 123 Post Avenue site, as discussed in Section 1.5 of this document, since remediation of the plume will not be achieved. This alternative relies solely on natural attenuation of contamination, which is not expected to occur in a significant manner based on existing data and the high oxygen content of the groundwater. However, the PCE plume is not currently impacting any of the nearby public water supply wells, and this remedy would allow for detection of the PCE plume via the sentinel well network before the plume is potentially captured by Westbury Well 11. Alternative 2 will also address the exposure pathway associated with the water supply well at the car wash.

Additionally, long-term groundwater monitoring will allow for monitoring and tracking the plume to ensure no future impacts to potential receptors.

Implementability

Modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring of the groundwater contaminant plume is readily implementable.

Cost

The cost associated with this alternative involves modification of the well at the car wash, installation of sentinel wells and long-term groundwater monitoring. The cost for of this alternative is significantly lower than the alternatives discussed below.

3.2.3 Alternative 3

Effectiveness

Alternative 3, groundwater extraction and treatment with discharge to a recharge basin, modification of the well at the car wash, installation of sentinel wells and long-term groundwater monitoring, would meet the remedial action objectives established for this site. Modification of the well would mitigate contact with PCE contaminated groundwater at the car wash. The installation of sentinel wells near Westbury Well 11 (N-5654) will allow for detection of contaminants in groundwater before they are potentially captured by the water supply well. Through extraction and treatment of the groundwater, this alternative would mitigate potential contact with groundwater and would therefore protect human health and the environment. Discharged water would be treated to meet all applicable regulatory standards.

Implementability

Construction, operation and maintenance of the groundwater extraction wells and treatment system is readily implementable. Limited space in the vicinity of the plume is available to install extraction wells, construct a treatment building and recharge basins for discharge of treated water. There is also a potential opportunity for the beneficial reuse of a portion of the treated water at Covanta which is located in close proximity to the site. Utilization of publicly owned right of ways will require approval from and coordination with public agencies such as the New York State Department of Transportation. The space constraints in the vicinity of the plume may impede implementation of this remedy. The necessary labor, equipment, materials and supplies are commercially available. However, the construction of a treatment building and a recharge basin are not easily implementable due to the above-referenced space limitations. Additionally, the conveyance of extracted water to the treatment building and from the building to the recharge basin(s) would require a series of piping routed along public streets. Modification of the car wash well and installation of sentinel wells are readily implementable both physically and from a regulatory perspective.

Cost

The cost of Alternative 3 is high; however, it is less than the cost of Alternative 4, chemical oxidation.

3.2.4 Alternative 4

Effectiveness

Since this technology relies on the ability for permanganate to contact contaminated groundwater, in-situ chemical oxidation using sodium permanganate will be effective at reducing the contaminants of concern if the required permanganate can be injected into the contaminated plume. Access issues to install the required injection points may impede the effectiveness of the alternative if the oxidant cannot be injected as necessary. Modification of the car wash well would be protective of human health and the environment and would prevent further migration of contaminated groundwater at the car wash. Installation of sentinel wells near Westbury Well 11 (N-5654) will allow for detection of contaminants in groundwater before they are captured by the water supply well.

Implementability

The number of injection wells that would be required to successfully remediate the PCE plume may make implementation of this alternative difficult. Working in right of ways for both the installation of the wells and injection of the oxidant will be difficult in a congested densely developed commercial and residential area. In addition, above ground and underground utilities will likely limit locations for installation of the wells. Access to privately owned properties may be required in order to install all required wells for this alternative. Additionally, the long injection period will likely require long-term road closures to facilitate the work, which will be problematic given the plume is located in a densely developed commercial area. Modification of the car wash well and installation of the sentinel wells are readily implementable both physically and from a regulatory perspective.

Cost

The cost of Alternative 4 is high; however, it does not include long-term operation and maintenance of a treatment system.

3.3 Summary of Evaluation of Alternatives

Provided in Table 3-1 is a summary of the preliminary evaluation of the remedial alternatives developed for the 123 Post Avenue site OU2.

With regard to selection of alternatives to be evaluated further in detail in order to select a remedial plan for the site, all of the remedial alternatives discussed above (Alternatives 1 through 4) are considered viable and will be evaluated in greater detail in Section 5.0.

Table 3-1

SUMMARY OF PRELIMINARY EVALUATION OF REMEDIAL ALTERNATIVES
123 POST AVENUE SITE – OPERABLE UNIT 2

Remedial Alternative		Effectiveness	Ease of Implementation	Relative Cost	Retained
Alternative 1	No Action	Low	High	Low	Yes
Alternative 2	No Action with Modification of the Well, Installation of Sentinel Wells and Long-term Groundwater Monitoring	Moderate	High	Low	Yes
Alternative 3	Groundwater Extraction and Treatment with Modification of the Well, Installation of Sentinel Wells and Long-term Monitoring	High	Low to Moderate	High	Yes
Alternative 4	In-situ Chemical Oxidation with Modification of the Well, Installation of Sentinel Wells and Long-term Monitoring	Moderate to High	Low to Moderate	High	Yes

4.0 DETAILED ANALYSIS OF ALTERNATIVES

Based on the preliminary evaluation of the remedial alternatives selected for the 123 Post Avenue site – OU2 in Section 4.0, all four of the alternatives developed for the site have been retained for further analysis. The following summarizes the alternatives to be evaluated in detail for remediation of groundwater in this section:

Alternative 1 – No Action

Alternative2 – No Action with Modification of the Car Wash Well, Installation of Sentinel Wells and Long-term Groundwater Monitoring

Alternative 3 - Groundwater Extraction and Treatment with Modification of the Car Wash Well, Installation of Sentinel Wells and Long-Term Groundwater Monitoring

Alternative 4 - In-situ Chemical Oxidation with Modification of the Car Wash Well, Installation of Sentinel Wells and Long-term Groundwater Monitoring

Provided below is a detailed evaluation of the alternatives. Based on this evaluation, a remedial plan for the site will be selected for regulatory agency approval and public comment. In accordance with federal (USEPA) and New York State guidance, the following feasibility study evaluation criteria will be addressed in this evaluation.

- Threshold Criteria
  - Protection of human health and the environment
  - Compliance with standards, criteria and guidelines (SCGs)/Applicable or Relevant and Appropriate Requirements (ARARs)
- Balancing Criteria
  - Short-term impacts and effectiveness
  - Long-term effectiveness and permanence
  - Reduction in toxicity, mobility and/or volume of contamination

- Implementability
- Cost

- Modifying Criteria
  - Regulatory agency acceptance

A description of each of these criteria is provided in Section 1.6 of this document.

Provided below is a comparative analysis of the remedial alternatives to each of the evaluation criteria presented above.

4.1 Protection of Human Health and the Environment

Alternative 1, no action, will not be protective of human health and the environment, since natural attenuation of the groundwater, without some form of active remediation, will allow continued migration of highly contaminated groundwater. Additionally, this alternative will not address the complete exposure pathway identified for the car wash well.

Alternative 2, no action with modification to the car wash well, installation of sentinel wells and long-term groundwater monitoring, will address the complete exposure pathway to contaminated groundwater at the car wash. It will also allow for detection of contaminants in groundwater via the sentinel well network before they are captured by Westbury Well 11 (N-5654). However, Alternative 2 will not address the contaminant plume and therefore will not be fully protective of human health and the environment. Natural attenuation of the groundwater, without some form of active remediation, will allow continued migration of contaminated groundwater. It should be noted that with the exception of the car wash water supply well, the PCE plume is not currently impacting any public water supply wells in the vicinity of the plume. Long-term groundwater monitoring will allow for monitoring and tracking of the plume to ensure no future impacts to potential receptors.

The effectiveness of Alternative 3, groundwater extraction and treatment and discharge to recharge basins with modification to the car wash well, installation of sentinel wells and long-term groundwater monitoring is a proven technology that would be protective of human health and the environment, since it would treat the contaminants of concern. There is one complete exposure pathway to contaminated groundwater and modification of the car wash well will effectively address this exposure pathway. It will also allow for detection of contaminants in groundwater via the sentinel well network before they are captured by Westbury Well 11 (N-5654). Long-term groundwater monitoring will allow for monitoring the effectiveness of the remedial system to ensure no future impacts to potential receptors.

Alternative 4, in-situ chemical oxidation with modification to the car wash well, installation of sentinel wells and long-term groundwater monitoring, will also address the complete exposure pathway to contaminated groundwater at the car wash. It will also allow for detection of contaminants in groundwater via the sentinel well network before they are captured by Westbury Well 11 (N-5654). In-situ chemical oxidation depends upon the ability of the sodium permanganate to reach the contaminants in groundwater. Sodium permanganate readily oxidizes VOCs with no intermediate byproducts. Where access to the plume is available, reduction of contaminant levels to below groundwater standards will be accomplished; however, the plume is located within a densely developed commercial area and the chemical injection program may be restricted due to lack of open space to complete injections. If wells cannot be installed due to access or utility issues, it may be difficult to inject oxidant in the required areas. Therefore, although in-situ chemical oxidation will be effective at reducing the levels of VOCs in groundwater, it may not be able to address the limits of the plume designated for remediation and, therefore, a portion of the plume may continue to migrate downgradient untreated.

As a result of this comparative analysis, Alternatives 3 and 4 would be the most protective of human health and the environment since these alternatives will treat the contaminated groundwater plume. The effectiveness of Alternative 4 would be contingent upon the ability to access the contaminant plume. Alternative 2 would address the complete exposure pathway at car wash; however, overall, it would not be protective of human health and the environment since it does not address the contaminant plume. Alternative 1 would not be protective of human health and the environment since it will continue to allow for downgradient migration of the contaminant plume and will not address the complete exposure pathway at the car wash.

4.2 Compliance with Standards, Criteria and Guidelines/ARARs

Alternative 1, no action, will not be compliant with any of the SCGs established for the site, since significant natural attenuation of the groundwater is not expected and migration of contaminants will continue.

Alternative 2, no action with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will address the complete exposure pathway at the car wash. It will also allow for detection of contaminants in groundwater via the sentinel well network before they are captured by Westbury Well 11 (N-5654). Overall, it will not be compliant with any of the SCGs established for the site, since significant natural attenuation of the groundwater is not expected, and migration of contaminants will continue.

Alternative 3, groundwater extraction and treatment and discharge to recharge basins or beneficial reuse with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will significantly reduce the level of PCE in the groundwater. Additionally, the treated water would be required to meet the New York State water effluent limitations prior to being discharged to the recharge basin(s). As discussed for Alternative 2, modification of the car wash well will address the complete exposure pathway at the car wash and installation of sentinel wells will allow for detection of contaminants in groundwater before they are captured by Westbury Well 11 (N-5654).

Similarly, Alternative 4, in-situ chemical oxidation with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will significantly reduce the level of PCE in the groundwater. However, the overall effectiveness of in-situ chemical oxidation in reducing PCE is contingent upon the ability of the oxidant to come in contact with the contaminated groundwater which may be limited due to access constraints.

Since this alternative will be performed in-situ without any aboveground treatment equipment after the initial installation, this alternative will meet all other applicable SCGs and ARARs established for the Site. Additionally, as discussed for Alternative 2, modification of the car wash well will address the complete exposure pathway at the car wash and installation of sentinel wells will allow for detection of contaminants in groundwater before they are captured by Westbury Well 11 (N-5654).

Based on the above comparison, Alternatives 3 and 4 will be the most compliant with the SCGs established for the site, followed by Alternative 2. Alternative 4 may not be able to treat the limits of the plume designated for remediation. Alternative 1 will not be compliant with SCGs/ARARs.

4.3 Short-term Impacts and Effectiveness

Implementation of Alternative 1, no action, will have no short-term adverse impacts relative to the surrounding community and can be implemented immediately. However, this alternative will not be effective in the short-term in reducing contaminant levels in groundwater, preventing further downgradient migration of contamination or addressing the exposure pathway at the car was well.

Implementation of Alternative 2, no action with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will have minimal short-term adverse impacts relative to the surrounding community and can be implemented immediately. All work to install the new water supply well and decommission the existing well will occur on the car wash property. The work to install three sentinel wells near Westbury Well 11 will have some short-term impacts, including minor disruptions to public roads and commercial parking lots, since the wells will be installed in a densely developed area. However, construction of the sentinel wells will take approximately 1 month. However, this alternative will not be effective in the short-term in reducing overall contaminant levels in groundwater or preventing further downgradient migration of contamination.

Alternative 3, groundwater extraction and treatment with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will have significant short term impacts since the extraction and treatment system is being constructed in a densely developed area. Once it is operating it will be immediately effective in mitigating migration of the contaminant plume and reducing elevated levels of PCE in groundwater; however, the groundwater extraction and treatment system will have to operate for many years in order to capture and remediate the plume. Alternative 3 includes the installation of approximately 4 groundwater extraction wells, and construction of a treatment building and recharge basin. Alternative 3 will also require a network of piping and pumps to convey water from the extraction wells to the treatment building and from the treatment building to the recharge basin and potentially to Covanta for reuse at their facility. Therefore, underground piping will need to be installed to convey extracted groundwater to the treatment system and from the treatment system to the recharge basin and potentially to Covanta's facility. Additional groundwater monitoring wells will need to be installed for long-term groundwater monitoring. Depending upon the location that is selected for all components of the groundwater extraction and treatment system, installation of the extraction wells, monitoring wells, underground piping, treatment building and recharge basin will likely cause disruption to public roads and commercial parking lots. Construction for Alternative 3 will take approximately 1 to 2 years to complete and the treatment system is expected to remain in operation for 30 years. As discussed in Alternative 2, all work associated with modification of the car wash well will occur on the car wash property. As also discussed in Alternative 2, the work to install three sentinel wells near Westbury Well 11 will have some short-term impacts, including minor disruptions to public roads and commercial parking lots, since the wells will be installed in a densely developed area. However, construction of the sentinel wells will take approximately 1 month.

Alternative 4, in-situ chemical oxidation with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will require installation of approximately 168 injection points at three different locations within the plume. Each injection point will be constructed using sonic drilling and will comprise permanent well points that can be reused for additional injections. Additional groundwater monitoring wells will need to be installed for long-term groundwater monitoring. Installation of the injection points will cause more surficial disruption than Alternative 2 but likely less surficial disruption than Alternative 3 given the expected long lengths of underground piping that would need to be installed. During installation and the subsequent injection program, public road closures will be required to facilitate the work. However, once completed, the flush mount covers on the injection points will not impact the roadways. The injection program will take approximately 1 to 2 years to complete and will require multiple staging areas for the 40% sodium permanganate, water and other equipment. This alternative is expected to be effective in the short term since remediation of the plume will be completed once the oxidant has been distributed to the subsurface and will not require long term operation and maintenance. As discussed in Alternative 2, all work associated with modification of the car wash well will occur on the car wash property. As also discussed in Alternative 2, the work to install three sentinel wells near Westbury Well 11 will have some short-term impacts, including minor disruptions to public roads and commercial parking lots, since the wells will be installed in a densely developed area. However, construction of the sentinel wells will take approximately 1 month.

Based on this comparative analysis, Alternatives 1 and 2 will have the least short-term impacts. However, Alternative 1 will not result in any reduction in the contaminant plume and will not address the complete exposure pathway identified at the car wash water supply well. While Alternative 2 addresses the complete exposure pathway identified at the car wash water supply well, it will not reduce the contaminant plume. Alternatives 3 and 4 will both have significant short-term impacts due to the fact that the contaminant plume is located within a densely developed commercial area and drilling and construction will be required within public rights of way and possibly private property. Implementation of Alternative 3 will take longer than implementation of Alternative 4 and will not be as effective in the short term as it will take many years for the system to capture and treat the contaminated groundwater.

Therefore, with regard to short-term impacts, Alternative 1 will have the least impact on the surrounding area, followed by Alternatives 2, and Alternatives 4 and 3, respectively. However, with regard to short-term effectiveness, Alternative 4 would be the most effective in the short term, followed by Alternatives 3, 2 and 1, respectively.

4.4 Long-term Effectiveness and Permanence

Alternative 1, no action, will not be effective or permanent in the long term.

Alternative 2, no action with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will not be effective or permanent in reducing the contaminant plume in the long term. Modification of the car wash well will effectively and permanently address the complete exposure pathway identified at the car wash water supply well. It should be noted that with the exception of the car wash water supply well, the contaminant plume is not currently impacting any public water supply wells. Installation of sentinel wells will allow for detection of contaminants in groundwater before they are potentially captured by Westbury Well 11 (N-5654). Long-term groundwater monitoring will allow for monitoring the effectiveness of the remedial system to ensure no future impacts to potential receptors.

By hydraulically controlling and treating contaminated groundwater, it is expected that Alternative 3 will be effective and permanent in the long-term. VOCs, including the contaminant of concern, PCE, would be permanently removed from groundwater through treatment with air stripping and granular activated carbon treatment. Alternative 3 will mitigate migration of the contaminant plume. Alternative 3 will also address the complete exposure pathway identified for the car wash water supply well. Finally, Alternative 3 will allow for detection of contaminants in groundwater before they are potentially captured by Westbury Well 11 (N-5654).

Alternative 4, in-situ chemical oxidation with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, is expected to be effective and permanent in the long term if the sodium permanganate is able to come in contact with the limits of the plume designated for remediation. If the plume cannot be entirely remediated, this alternative will result in a continuing impact in the surrounding area. As discussed above, Alternative 4 will also address the complete exposure pathway identified for the car wash water supply well and allow for detection of contaminants in groundwater before they are potentially captured by Westbury Well 11 (N-5654).

In summary, Alternatives 3 and 4 will likely be the most effective and permanent alternatives in reducing the contaminants of concern in groundwater in the long term. However, the effectiveness of Alternative 4 is dependent upon the ability of sodium permanganate to come into contact with the limits of the plume designated for remediation. While Alternative 2 addresses the complete exposure pathway identified at the car wash, it will not result in a reduction in the contaminant plume. Alternative 1 will not be effective or permanent in the long term.

4.5 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternative 1, no action, will not be effective at reducing the toxicity, mobility or volume of contaminants at the site, since natural attenuation is not expected to be effective in the foreseeable future and contaminants will continue to migrate downgradient.

Similar to Alternative 1, Alternative 2 with no action and modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will not be effective at reducing the toxicity, mobility or volume of contaminants at the site, since natural attenuation is not expected to be effective in the foreseeable future and contaminants will continue to migrate downgradient. However, this alternative will address the complete exposure pathway identified at the car wash and allow for detection of contaminants in groundwater before they are potentially captured by Westbury Well 11 (N-5654).

Alternative 3, groundwater extraction and treatment and discharge to a recharge basin or beneficial reuse, with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring will be effective at reducing the toxicity, mobility and volume of PCE in groundwater at the site. The use of extraction wells will mitigate migration of contaminated groundwater. Contaminated groundwater will be treated at the surface via air stripping, advanced oxidation processes and granular activated carbon processes, thereby reducing the total volume of contaminated groundwater. PCE trapped on the granular activated carbon adsorption media will be destroyed during regeneration or disposal in accordance with applicable regulations. As discussed above, Alternative 3 will also address the complete exposure pathway identified at the car wash and allow for detection of contaminants in groundwater before they are potentially captured by Westbury Well 11 (N-5654).

Alternative 4, in-situ chemical oxidation with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will be effective at reducing the toxicity, mobility and volume of PCE in groundwater at the site through the complete destruction of the PCE in the groundwater. As discussed above, the effectiveness of this alternative is based on contact of the permanganate with contaminated groundwater. Contaminated groundwater that does not to come in contact with permanganate will not be treated. Additionally, as discussed above, Alternative 4 will also address the complete exposure pathway identified at the car wash and allow for detection of contaminants in groundwater before they are potentially captured by Westbury Well 11 (N-5654).

Based on this comparative analysis, Alternative 3 will be the most effective followed by Alternative 4. Alternative 4's effectiveness is dependent upon sodium permanganate coming into contact with the contaminant plume. Alternatives 1 and 2 will not be effective at reducing the toxicity, mobility or volume of the contaminant plume. However, Alternative 2 will address the complete exposure pathway identified at the car wash.

4.6 Implementability

Alternative 1, no action, can be easily implemented.

Alternative 2, no action with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, can also be easily implemented. Alternative 2 will require obtaining authorization from and coordination with the property owner of the car wash for installation of the new water supply well and abandonment of the existing water supply well. Installation of three sentinel wells will require road closures in a densely developed commercial area. Road opening permits, access agreements and coordination with local and regional government agencies may be required for the well installation. Work required to modify the car wash well and install the sentinel wells should take approximately one month.

Alternative 3, groundwater extraction and treatment and discharge to a recharge basin or beneficial reuse, with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, is a commercially available technology with all necessary labor, materials and supplies readily accessible. It has been demonstrated at many sites to meet all remediation goals, as well as to prevent further migration of contamination. A pumping test will be required to optimally design the groundwater extraction system, including the number of wells, well spacing and pumping rates to effectively remediate the contaminant plume. The effectiveness of this remedy can be easily monitored through the use of groundwater monitoring wells. Potentially acquiring access to land and constructing the extraction wells, treatment building and recharge basin affects the implementability of Alternative 3. Installation of below grade piping to convey water from the extraction wells to the treatment building, and from the treatment building to the recharge basin or to the Covanta facility for beneficial reuse presents another challenge to implementing Alternative 3. The above work will require road opening permits, access agreements and coordination with local and regional government agencies. Additionally, discharging to a recharge basin will require a SPDES permit equivalency. Construction of Alternative 3 will take approximately 1 to 2 years and it is estimated that the treatment system will need to stay in operation for 30 years. As discussed in Alternative 2, modification of the car wash well and installation of sentinel wells are easily implementable.

Alternative 4, in-situ chemical oxidation with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, is also a commercially available technology with all the necessary labor, equipment, materials and supplies for installation of this alternative are readily available. It should be noted that Alternative 4 requires approximately 14,000,000 pounds of 40% sodium permanganate. Acquiring this large volume of sodium permanganate presents a challenge to implementing in-situ chemical oxidation. Installation of the injection points and completion of the injection program will require significant road closures in a densely developed commercial area. The above work will require road opening permits, access agreements and coordination with local and regional government agencies. The injection program is anticipated to take approximately 1 to 2 years. The location, number of injection points and time required to complete the Alternative present a challenge to the implementability of in-situ chemical oxidation. Similar to the alternative discussed above, the effectiveness of this remedy can be easily monitored through the use of groundwater monitoring wells. Additionally, as discussed in Alternative 2 modification of the car wash well and installation of sentinel wells are easily implementable.

All of the alternatives are implementable with the simplest being Alternatives 1 and 2. Alternatives 3 and 4 have a variety of challenges that affect their respective implementability. The challenges associated with Alternatives 3 and 4 are due to the contaminant plume's size, depth and thickness, as well as being located in a densely developed commercial area. Since complete installation of an extraction and treatment system, underground piping and recharge basin and the need for space needed to house the above treatment system, Alternative 3 will be more disruptive to the surface and take a longer period than Alternative 4.

4.7 Cost

The estimated capital, long-term operation and maintenance (O&M), and monitoring present worth costs associated with the alternatives are presented in Table 4-1. A detailed breakdown of each estimate is provided in Appendix A.

The following assumptions were utilized in the preparation of the cost estimates:

- Costs are rounded to the nearest thousand dollars.
- Remedial technology costs were obtained from vendors experienced in installation and operation of these systems.

Alternative 1, no action, would have the lowest cost, since there are no capital costs associated with this alternative. Alternative 2, no action with modification of the car wash well, installation of sentinel wells and long-term groundwater monitoring, will have the next lowest cost since the remedy is simple and requires minimal work to complete. The cost for Alternative

4 is slightly greater than Alternative 3; however, Alternative 4 does not require long term operation and maintenance costs for the groundwater extraction and treatment system.

Table 4-1

ALTERNATIVES COST SUMMARY
123 POST AVENUE SITE - OPERABLE UNIT 2

Alternative	Estimated Capital Cost	Estimated Contingency and Engineering Fees	Present Worth of Annual Operating Maintenance and Monitoring Costs	Total Estimated Costs Based on Present Worth
1	$0	$0	$0	$0
2	$510,000	$163,200	$141,000	$814,200
3	$22,236,171	$7,115,575	$7,646,257	$37,546,002
4	$34,083,000	$6,506,560	$99,000	$40,688,560

A summary of the comparison of alternatives is provided in Table 4-2.

Table 4-2

SUMMARY OF REMEDIAL ALTERNATIVE COMPARATIVE ANALYSIS
123 POST AVENUE – OPERABLE UNIT 2

Evaluation Criteria	Alternative 1 – No Action	Alternative 2 – No Action with Modification of the Car wash well, Installation of sentinel wells and Long-term Groundwater Monitoring	Alternative 3 – Groundwater Extraction and Treatment with Modification of the Car wash well, Installation of sentinel wells and Long-term Groundwater Monitoring	Alternative 4 – In-situ Chemical Oxidation with Modification of the Car wash well, Installation of sentinel wells and Long-term Groundwater Monitoring
Protection of Human Health and the Environment	4	4	2	3
Compliance with Standards, Criteria and Guidelines	4	4	2	2
Short-term Impacts and Effectiveness	2	2	3	2
Long-term Effectiveness and Permanence	4	4	2	3
Reduction of Toxicity, Mobility or Volume through Treatment	4	4	2	3
Implementability	1	1	4	4
Cost	1	1	3	3
Regulatory Agency Acceptance	4	4	1	1
Total	24	24	19	21

Note: Lowest numerical score is highest ranking.

APPENDIX A

DETAILED COST ESTIMATE

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Feasibility Study

Alternative 2
No Action with Supply Well Modification, Installation of Sentinel Wells and Long-Term Groundwater Monitoring
Cost Estimate

Item	Quantity	Units	Unit Cost	Total
Capital Costs				
Long-term Monitoring				
Installation of monitoring wells (3 downgradient)	-	Lump Sum	$125,000	$125,000
Installation of sentinel wells (3 wells)	-	Lump Sum	$125,000	$125,000
Modification of the Supply Well				
Mobilization/Demobilization	-	Lump Sum	$10,000	$10,000
Installation of Water Supply Well	-	Lump Sum	$200,000	$200,000
Abandonment of the Water Supply Well	-	Lump Sum	$50,000	$50,000
		TOTAL ESTIMATED CAPITAL COST:		$510,000
Contingency and Engineering Fees				
Contingency allowance (10%)				$51,000
Engineering fees (20%)				$112,200
Estimated Contingency and Engineering Fees				$163,200
TOTAL ESTIMATED CAPITAL COST				$673,200
Groundwater Monitoring Costs Per Event				
Groundwater Sampling	5	Mandays	$600	$3,000
Purge Water Disposal	12	Drums	$135	$1,620
Waste Pick Up	-	Lump Sum	$350	$350
Equipment,Materials, and Supplies	-	Lump Sum	$1,000	$1,000
Sample Analysis*	5	Samples	$100	$500
	Estimated per event monitoring costs			$6,470
	Present worth of annual groundwater monitoring (30 yrs, i=5%)**			$141,000
	Remedial Alternative 2 Total Estimated Costs			**$814,200**

*Sampling analysis includes volatile organic parameters.
**Sampling frequency includes 2 times per year for the first 10 years, 1 times per year for the next 10 years and biannually for the next 10 years.

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Feasibility Study

Alternative 1
No Action
Cost Estimate

Item	Quantity	Units	Unit Cost	Total
Capital Costs				
N/A				
		Estimated Capital Cost		$0
Contingency and Engineering Fees				
Contingency allowance (10%)				$0
Engineering fees (20%)				$0
	Estimated Contingency and Engineering Fees			$0
	TOTAL ESTIMATED CAPITAL COST			$0

REMEDIAL ALTERNATIVE 1 TOTAL ESTIMATED COST: $0.00

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Feasibility Study

Alternative 3
Groundwater Extraction and Treatment with Modification of the Supply Well, Installation of Sentinel Wells and Long-term Groundwater Monitoring
Cost Estimate

Item	Quantity	Units	Unit Cost	Total
Capital Costs				
Long-term Monitoring				
Installation of monitoring wells (3 downgradient)	-	Lump Sum	$125,000	$125,000
Installation of sentinel wells (3 wells)	-	Lump Sum	$125,000	$125,000
Modification of the Supply Well				
Mobilization/Demobilization	-	Lump Sum	$10,000	$10,000
Installation of Water Supply Well	-	Lump Sum	$200,000	$200,000
Abandonment of the Water Supply Well	-	Lump Sum	$50,000	$50,000
Pumping Test				
(includes installation of pumping well and 4 observation wells and sampling)	-	Lump Sum	$263,105	$263,105
Groundwater Extraction and Treatment System				
Mobilization/demobilization	-	Lump Sum	$250,000	$250,000
Installation of 3 extraction wells and pump system	3	Each	$600,000	$1,800,000
Mixed Media Filter (includes freight and installation support)	3	Each	$211,000	$633,000
Air strippers (includes freight to site)	4	Each	$206,250	$825,000
Granular activated carbon system skid (includes virgin coconut carbon, freight and labor to set up systems)	2	Each	$357,200	$714,400
12-stage bag filter housings	4	Each	$55,000	$220,000
Advanced Oxidation Process system (includes all system components, piping and electrical)	2	Each	$4,100,000	$8,200,000
Pumps/piping/chemical feed/controls	-	Lump Sum	$437,500	$437,500
Below Grade Piping	15,000	Linear Feet	$370	$5,550,000
Electrical supply	-	Lump Sum	$400,000	$400,000
Building (2.88 MGD)	-	Lump Sum	$1,250,000	$1,250,000
Miscellaneous equipment and site work	-	Lump Sum	$250,000	$250,000
Recharge basin*	-	Lump Sum	$650,000	$650,000
			TOTAL ESTIMATED CAPITAL COST:	$22,236,171
Contingency and Engineering Fees				
Contingency allowance (10%)				$2,223,617
Engineering fees (20%)				$4,891,958
Estimated Contingency and Engineering Fees				$7,115,575
TOTAL ESTIMATED CAPITAL COST				$29,351,745

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Annual Operating and Maintenance Costs				
Groundwater Extraction and Treatment System				
Extraction well pumps (includes service and power costs)	-	Lump Sum	$30,000	$30,000
Treatment system (includes service and power)	-	Lump Sum	$50,000	$50,000
Treatment building and equipment (includes power and chemical costs)	-	Lump Sum	$40,000	$40,000
Granular Activated Carbon Exchange	40,000	Pounds	$1	$46,120
Bag Filter exchange	2,496	Lump Sum	$5	$12,480
25% Hydrogen Peroxide	-	Lump Sum	$74,000	$74,000
AOP Maintenance (includes replacement of bulbs, drivers, sleeves and sensors)	-	Lump Sum	$56,000	$56,000
AOP Reactor Electrical Cost	-	Lump Sum	$168,000	$168,000
System O&M labor	208	Hours	$100	$20,800
	Annual Cost			$497,400
	Present worth of annual operation & maintenance cost (30 yrs, i=5%)			$7,646,257
Discharge Monitoring Costs Per Event				
Discharge sampling	1	Mandays	$600	$600
Equipment, materials and supplies	-	Lump Sum	$200	$200
Sample analysis**	1	Samples	$650	$650
	Estimated per event monitoring costs			$1,450
	Present worth of annual discharge monitoring (30 yrs, i=5%)			$268,000
Groundwater Monitoring Costs (per event)				
Groundwater Sampling	5	Mandays	$600	$3,000
Purge Water Disposal	12	Drums	$135	$1,620
Waste Disposal	-	Lump Sum	$350	$350
Equipment,Materials, and Supplies	-	Lump Sum	$1,000	$1,000
Sample Analysis**	5	Samples	$100	$500
	Estimated per event monitoring costs			$6,470
	Present worth of annual groundwater monitoring (30 yrs, i=5%)***			$280,000
	REMEDIAL ALTERNATIVE 3 TOTAL ESTIMATED COST:			**$37,546,002**

*Does not include cost for land acquisition
**Sampling analysis includes volatile organic parameters.
***Sampling frequency includes 4 times per year for the first 10 years, 2 times per year for the 10 years and 1 time per year for the next 10 years.

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Feasibility Study

Alternative 4
In-Situ Chemical Oxidation with Modification of the Supply Well, Installation of Sentinel Wells and Long-Term Groundwater Monitoring
Cost Estimate

Item	Quantity	Units	Unit Cost	Total
Capital Costs				
Long-term Monitoring				
Installation of monitoring wells (2 upgradient, 3 downgradient)	-	Lump Sum	$175,000	$175,000
Installation of sentinel wells (3 wells)	-	Lump Sum	$125,000	$125,000
Modification of the Supply Well				
Mobilization/Demobilization	-	Lump Sum	$10,000	$10,000
Installation of Water Supply Well	-	Lump Sum	$200,000	$200,000
Abandonment of the Water Supply Well	-	Lump Sum	$50,000	$50,000
Bench and pilot scale test				
(includes water sample analysis during pilot test)	-	Lump Sum	$150,000	$150,000
Chemical Oxidation System				
Mobilization/demobilization	-	Lump Sum	$250,000	$250,000
Injection Point Installation	-	Lump Sum	$5,145,000	$5,145,000
Chemical Injection Program	-	Lump Sum	$4,800,000	$4,800,000
Reagent Costs	-	Lump Sum	$22,000,000	$22,000,000
Reagent Delivery Costs	310	Truck Load	$3,800	$1,178,000
		TOTAL ESTIMATED CAPITAL COST:		$34,083,000
Contingency and Engineering Fees				
Contingency allowance (10%)				$3,408,300
Engineering fees (20%)*				$3,098,260
Estimated Contingency and Engineering Fees				$6,506,560
TOTAL ESTIMATED CAPITAL COST				$40,589,560

123 Post Avenue - OU2
Feasibility Study

Operation and Maintenance Costs

Groundwater Monitoring Costs (per event)				
Groundwater Sampling	7	Mandays	$600	$4,200
Purge Water Disposal	18	Drums	$135	$2,430
Waste Disposal	-	Lump Sum	$350	$350
Equipment,Materials, and Supplies	-	Lump Sum	$1,000	$1,000
Sample Analysis**	10	Samples	$100	$1,000
	Estimated per event monitoring costs			$8,980
	Present worth of annual groundwater monitoring (10 yrs, i=5%)***			$99,000
	REMEDIAL ALTERNATIVE 4 TOTAL ESTIMATED COST:			**$40,688,560**

*Reagent costs were not included since they will not impact the Engineering fees
**Sampling analysis includes volatile organic parameters.
***Sampling frequency includes 2 times per year for the first 5 years, 1 times per year for the next 5 years.